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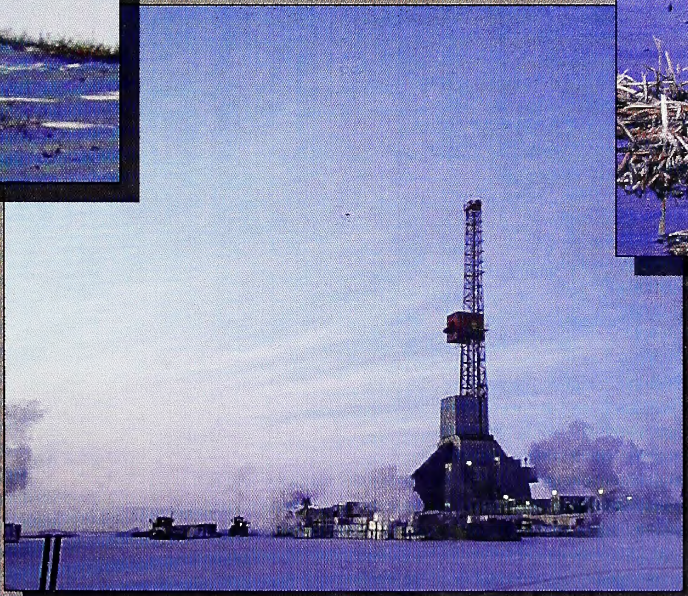
Northeast
National Petroleum Reserve-Alaska

DRAFT Supplemental
Integrated Activity Plan/Environmental Impact Statement

Volume 2: Chapter 4, Sections 4.1-4.6



Alaska

In Cooperation with the
North Slope Borough

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Our Vision

To enhance the quality of life for all citizens through the balanced stewardship of America's public lands and resources.

Our Mission

To sustain the health, diversity, and productivity of the public lands for the use and enjoyment of present and future generations.

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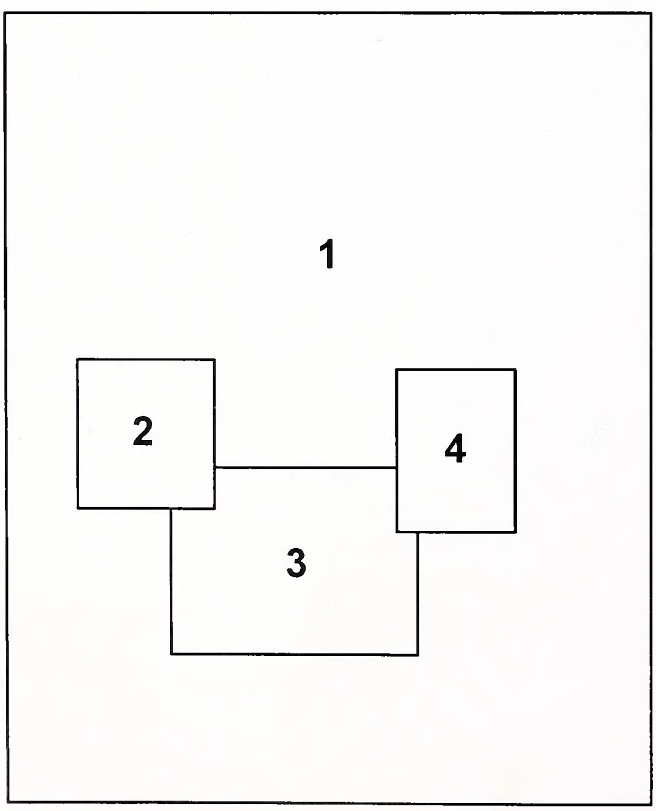

BLM Cover Photos:

1. Teshepuk Lake, Alaska. Photo by Richard Kemnitz.
2. Caribou, northern Alaska.
3. Drilling Rig at Hunter A well in the Northeast National Petroleum Revserve-Alaska. Photo by BLM Branch of Energy
4. Canadian Goose, northern Alaska.

Northeast National Petroleum Reserve–Alaska

Draft

Supplemental Integrated Activity Plan/ Environmental Impact Statement

VOLUME II:

Chapter 4, sections 4.1-4.6

Prepared by

U.S. Department of Interior
Bureau of Land Management
Anchorage, Alaska

In Cooperation with the North Slope Borough

August 2007

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CHAPTER IV: ENVIRONMENTAL CONSEQUENCES

4.1 INTRODUCTION

This section examines how authorized activities, including oil and gas exploration and development and non-oil and gas activities, may impact natural, cultural, and socioeconomic resources in the planning area under each alternative. The analyses for each alternative focuses on the potential impacts that may result from opening up areas currently closed to oil and gas exploration and development and from implementing prescriptive or performance-based required operating procedures (ROPs) and lease stipulations. The impacts associated with Alternative A incorporates by reference the discussion of the Environmental Consequences of the Preferred Alternative in the 1998 Northeast IAP/EIS (see 1998 Northeast IAP/EIS; pages IV.6.1 through IV.6.88) and will focus further on those potential impacts that may have changed since the analysis was done. In that IAP/EIS, our current No Action Alternative was the Preferred Alternative as modified by the Record of Decision (ROD) for the 1998 Northeast IAP/EIS.

Within each resource area, applicable direct and indirect impacts are evaluated. In addition, cumulative impacts, unavoidable adverse impacts, and other impacts assessments are provided. These impact descriptions can be found in the following subsections:

- **Direct impacts** – Those effects that occur at the same time and in the same general location as the activity causing the effects (see **sections 4.3, 4.4, 4.5, and 4.6**).
- **Indirect impacts** – Those effects that occur at a different time or in a different location than the activity to which the effects are related (see **sections 4.3, 4.4, 4.5, and 4.6**).
- **Cumulative impacts** – Those effects that result from the incremental impact of the action when it is added to other past, present, and reasonably foreseeable future actions (see **section 4.7**).
- **Unavoidable adverse commitments** – Those effects that could occur as a result of implementing any of the action alternatives. Some of these effects would be short term, while others could be long term (see **section 4.8**).
- **Relationship between the local short-term uses and maintenance and enhancement of long-term productivity** – Discusses the short-term effects of the potential use of the planning area, i.e., the effects during the period of oil exploration and development, and the long-term effects for the indefinite future (see **section 4.9**).
- **Irreversible commitments** – Those commitments that cannot be reversed, except perhaps in the extreme long term (see **section 4.10**).
- **Irretrievable commitments** – Those commitments that are lost for a period of time (see **section 4.10**).
- **Low-probability, very large oil spill** – Discusses the impacts that may be associated with a very unlikely very large oil spill, i.e., greater or equal to 120,000 barrels (see **section 4.11**).

A summary of the relative degree of predicted effects for each resource was provided in Chapter 2, Table 2-3. All effects disclosed in this chapter and in Table 2-3 assume that there would be compliance with the direction provided by lease stipulations and ROPs identified in Chapter 2.

This chapter should be read together with Chapter 2 (Alternatives), which explains the alternatives, and Chapter 3 (Affected Environment), which describes the important resources and their occurrence and status within the planning area. The analyses of environmental consequences in this chapter build upon and relate to information presented in these earlier chapters to identify which resources may be impacted and how and where impacts might occur under each of the alternatives. The maps, tables, and figures may be particularly useful to the reader's understanding of the potential impacts of each alternative upon the different resources that occur in the planning area.

As noted above, each of the alternatives includes protective measures in the form of lease stipulations and, in the case of Alternatives B, C, and D, ROPs. The effectiveness of protective measures is evaluated for each resource and summarized in Chapter 2, Table 2-2. There are also NSB, state, and Federal agency (e.g. USFWS, USEPA) regulations that govern activities in the planning area. For example, there are state and Federal requirements that operators must have approved oil spill contingency plans. There are also state regulations that prohibit the harassment of wildlife by use of aircraft, snowmachines, or boats (5 AAC). Finally, in this chapter some additional "mitigation measures," as the term is used in BLM's NEPA Handbook (p. V-20), are suggested that may further reduce impacts. These mitigation measures are not part of the alternatives. Rather they are suggestions of additional means to lessen impacts that are identified in the impact analysis in this chapter. Some may not be within BLM's authority to implement and thus would require the involvement of other agencies to effectuate them. These mitigation measures, along with a description of their effectiveness to mitigate impacts as well as the impacts these measures may themselves create, are included to allow for public consideration and comment. BLM's ROD will identify which mitigation measures identified in Chapter 4 BLM will adopt.

4.2 BASIC ASSUMPTIONS FOR THE ENVIRONMENTAL CONSEQUENCES ASSESSMENT

4.2.1 Ground-impacting Management Actions

Ground-impacting management actions refer to activities managed through BLM's regulatory and permitting processes. These activities could have some level of impact "on the ground" in the planning area. For this Supplement, ground-impacting activities have been divided into those associated with, and those not associated with, oil and gas exploration and development.

4.2.1.1 Activities Not Associated With Oil and Gas Exploration and Development

This section describes activities undertaken by BLM or requiring BLM authorization that are not associated with oil and gas exploration and development that could occur within the planning area, including their probable location, their anticipated frequency of occurrence, and the time of year in which they would likely take place. The anticipated extent of some of these activities under each of the alternatives is summarized in Table 4.2-A. Stipulations currently applied to BLM authorizations for non-oil and gas activities are presented in Appendix D, which addresses the current stipulation scheme for both oil and gas activities and non-oil and gas activities. These prescriptive stipulations would be retained under Alternative A (the No Action alternative); whereas under Alternatives B-D they would be replaced by a combination of performance based stipulations and ROPs (see Appendices E and F). Generally speaking, among the alternatives little or no difference is expected in the type or degree of impacts associated with non-oil and gas activities.

Table 4.2-A. Summary of Selected Non-Oil and Gas Related Management Activities[1]

Activity	Alternative A No Action Alternative	Alternatives B, C, and D
Aircraft Use [2]		
Point-to-point	Regular to daily	Same as Alternative A
Wildlife aerial	21 days during June and July	Same as Alternative A
Other Aerial surveys	Several 1- to 3-week periods	Same as Alternative A
Excavation and Collection		
Research/archeologic	4-6 acres disturbed	Same as Alternative A
Ground Activities [3]		
Large camps[4]	12 weeks	Same as Alternative A
Small camps	6 to 12 weeks	Same as Alternative A
Overland moves	20 to 60 trips	Same as Alternative A
Recreation (Colville River float trip parties) [5]		
Above Umiat	6 with SRPs[6]; 3 casual parties	Same as Alternative A
Below Umiat	8 with SRPs; 5 casual parties	Same as Alternative A

[1] All estimates are for levels of annual activity.
[2] This does not include use that is associated directly with oil and gas development or recreation. It also assumes that fixed-wing aircraft and helicopters are used and that use occurs almost exclusively in summer.
[3] Camps in this category are not associated directly with oil and gas development or recreation and assumes that all camps occur in summer.
[4] Large camps are at least 15 persons and may have 5,000 gallons of fuel. Camps are likely to be located at Umiat, Lonely, Ivotuk, Inigok, and sites near the headwaters of the Kiligwa and Meade rivers.
[5] Average of four persons per party.
[6] SRPs = Special Recreation Permits (i.e., guided and regulated by the BLM).

Aircraft Use

Almost all aircraft activity would take place during the summer. While it is likely that aircraft would fly over nearly all of the planning area, some areas would receive greater use than other areas. Aircraft activity associated with surveying resources and monitoring human use would be concentrated along the Colville and Ikpikpuk rivers. Use of aircraft to complete cultural and paleontological surveys would most likely occur in the central portion of the planning area. Aerial wildlife surveys would be most common during late June and early July, over caribou and waterfowl habitat areas.

Watercraft Use

Watercraft would be allowed for summer transportation and supply. Non-recreational airboat use would be allowed on all streams, lakes, and estuaries. Boats and other watercraft would likely be used by researchers during study efforts if facilities or areas of concern were located near large water bodies such as the Beaufort Sea, rivers, or large, deepwater lakes. These activities would occur during the summer months, but the type of activities and their frequency and locations remain speculative because data quantifying these activities have not been collected for the planning area.

Excavation and Collection

Excavating and collecting archaeological, paleontological, geologic, and soil resources occurs during the summer. All excavation is done using a trowel or hand shovel, is usually limited to areas of several square feet, and rarely extends more than 3 feet below the surface. If an archaeological site is studied in detail or if a geologic section is mapped, then larger areas might be excavated. Excavations are backfilled, and in most cases the vegetative layer is replaced atop the excavation. Most excavation would probably occur within the primary drainages of the planning area.

Ground Activities and Camps

Ground activities include small groups of scientists hiking across tundra or recreationists floating down a river. Ground camps range from those with their own aircraft to those with only a backpack's worth of supplies. Larger camps include a fuel bladder of up to 5,000 gallons, or fuel in drums, and might have as many as 15 people. Smaller parties use "fly" camps that are set up and moved every few days by boat, raft, or aircraft, and have nothing more than stove fuel. Backpack camps have even fewer supplies than fly camps and tend to move every day.

Small camps might be located throughout the planning area. Larger camps would most likely be placed at the Inigok airstrip, the Lonely DEW-Line site, and the Ivotuk airstrip, with a temporary camp on the Kiligwa River (Map 3-44). All of these camps would have fuel facilities, and a fuel cache might be established at some sites even if a camp were not present. Caches of jet fuel, commonly created to facilitate more economical aircraft use, must be equipped with spill clean-up material, and a cache of more than 50 gallons must be contained within a portable dike. Some solid wastes can be burned on site, and all non-burnable wastes would be removed. Human waste at small temporary camps is disposed of as recommended in the National Outdoor Leadership School's Leave No Trace, Alaskan Tundra guidelines. Use of the Inigok airstrip and pad is likely to remain at current levels or increase slightly over the next few years to support Native allotment fieldwork and monitoring of species of concern.

Solid and Hazardous Waste Removal and Remediation

Wastes, including those considered hazardous, are associated with human activity. A phased approach would be used to address hazardous and solid wastes in the planning area. This process would include verification and site evaluation of uncontrolled releases of hazardous substances on public land. The process for hazardous waste removal, described below, is consistent with guidance and regulations from CERCLA and the National Contingency Plan.

Initial Incident/Site Examination

In response to a discovery that a hazardous substance has been released, or the threat of a release into the environment, trained personnel perform an initial incident/site examination, confirming the release and verifying land ownership. This inspection and verification of discovery information potentially requires the use of helicopter or fixed-wing aircraft to move personnel to the site. Time spent on these activities would likely amount to 2 to 3 weeks per field season, but would depend on the number and types of reports or discoveries.

If the initial examination were to suspect or verify a release, a risk assessment would be completed to determine whether the situation posed an imminent threat to either public health

or sensitive environments. If the situation warranted immediate action, an emergency response or removal action could be initiated.

Site Evaluation

If the initial examination verified that the release of a reportable quantity of a hazardous substance (as defined in 40 CFR § 302.4) occurred, a threat existed, or a release was suspected but the situation did not warrant an emergency response, a site evaluation would be conducted. The site evaluation process would be concurrent with identifying potential responsible parties. The responsible party, once identified, would complete, under Federal and state oversight, all remaining evaluative and remedial actions.

The first step in the site evaluation is to document whether the released material is a hazardous substance and to identify the potential targets of impact. Collection of non-intrusive samples is often required. The site evaluation also determines the need for, and appropriateness of, removal actions and whether expanded sampling is required. Expanded sampling programs take approximately 2 weeks per site and often involve the use of shovels and hand augers.

It is estimated that 20% of release sites would need additional site characterization, based on analytical results of the site evaluation (for example, if sensitive potential targets or impact pathways are identified). Advanced studies to determine the extent of contamination typically require 3 to 4 weeks of field time, and may involve the use of drill rigs for deep sampling or hydropunches and backhoes for near-surface sampling. Approximately 80% of the drilled holes are backfilled immediately, and the remaining borings usually become monitoring wells. The final recommendation of the site evaluation may call for removal of contaminated material or other remediation measures.

If further investigation of the site was necessary, a remedial site evaluation could be required to determine the relative significance of the site in terms of risk to targets. This stage would also identify cost-effective and efficient permanent solutions for important sites. These studies generally address complex situations that require long-term treatments, and are subject to the regulatory time frames for submitting remedial reports once the process has been initiated and the sites are published in the Federal Register.

Site Clean-up

Areas that support relatively high levels of human contact and biologically sensitive areas would have the highest priority for contaminant removal actions. At lower priority sites, alternatives to removal could include in-situ treatments such as fencing the site to secure it and prevent contact by humans or wildlife, or capping the contaminated area with clean soil or gravel.

During removal, contaminated materials would be excavated (generally no deeper than 5 feet) and removed for treatment and disposal, if necessary. Disturbed areas would be backfilled and leveled, and erosion-control measures would be engineered. Removal activities could involve heavy equipment, such as large and small backhoes, front-end loaders, bulldozers, dump trucks, pickups, and all-terrain vehicles. This type of equipment would be transported overland in winter, or a barge could be used if the site was accessible by water. At sites where cleanup could only be accomplished in summer, a gravel pad or road might be constructed for use during the operation to protect the underlying soil and vegetation, and then removed after project completion.

Overland Moves and Other Land Use Permits

BLM issues minimum impact rights-of-way for overland moves to bring supplies to villages. Current management policy for the planning area allows only those activities that would have a negligible impact on the environment. Permafrost underlies the entire planning area, and floodplains/wetlands cover the majority of the planning area. The poor soil conditions in the planning area limit BLM's approval of most land use proposals for summer operations. Because of the fragile nature of thawed tundra during the summer, permit sites are restricted to durable areas such as gravel bars, beaches, or existing gravel pads. Vehicles allowed for use in overland moves would exert low ground pressure and be permitted to travel only over snow-covered ground frozen to a sufficient depth to minimize soil and vegetation impacts. Typically, overland moves would originate in Prudhoe Bay or Nuiqsut, and would take place exclusively on offshore ice, if conditions allowed. If the ice were determined to be unsound, portions of the trip would be made overland, following the shoreline. For safety reasons, moves farther inland could also occur. Overland moves would typically begin in December, when there is adequate snow cover and the ground is frozen, and ends in early May. On a yearly basis, 20 to 60 trains of 10 to 15 vehicles and attached sleds could engage in overland travel. The width of overland trails is approximately 12 feet wide. Should oil and gas exploratory drilling and development increase the amount of general activity on the North Slope, the number of overland moves would likely be closer to the high end of this range.

BLM may issue minimum-impact permits per 43 CFR Part 2920 for a variety of uses. For example, the NSB is authorized to maintain a wildlife observation cabin on the north shore of Teshekpuk Lake, accessed by airstrip or boat and used year-round. Similar permits could be authorized in the planning area.

Recreation

BLM issues Special Recreation Permits (SRPs) to commercial recreation operators, such as hunting and float-trip guides, who focus their activity along the Colville River. A typical hunting or float trip would consist of four people, and would take place in August or the first week of September. A limited number of SRPs could also be associated with other types of use. Float-equipped aircraft could be used to take hunters to lakes or sightseers to the Colville River. These flights could result in camping within the planning area at a level similar to that of fly camps or backpack camps.

Floating parties along the Colville River would carry enough fuel for a small stove and their boat engines. They would typically camp for no more than one night in any one place, and their camping practices and impacts would generally be consistent with those of fly camps or backpack camps described earlier in this section under Ground Activities and Camps.

4.2.1.2 Oil and Gas Exploration and Development Activities

I. Introduction

This section provides an estimate of the levels of petroleum-related activities and associated surface disturbances for each alternative. It also presents the oil and gas resource estimates in the planning area and identifies the assumptions used to determine the type and level of projected oil and gas activity. The estimates and assumptions are preceded by a general description of the activities typically associated with oil and gas operations on the North Slope

of Alaska. The petroleum-related activities described in this section are applicable in a general sense because the timing and location of future commercial-sized discoveries cannot be accurately predicted until exploration of those reserves occurs. However, it is reasonable to expect that new technologies and designs developed in the future will augment exploration and development efforts and will enhance the safety and efficiency of operations while minimizing the effects of oil and gas activity on the environment.

Current state-of-the-art technologies and project designs are used to project scenarios for future petroleum development in the planning area. Petroleum-related activities include conducting seismic operations; constructing ice roads for transporting equipment and supplies for winter drilling of exploration wells; drilling exploration and delineation wells; constructing gravel pads, roads connecting production pads to main facilities, and landing strips; drilling production and service wells; installing pipelines; and constructing oil and gas processing facilities. Impacts caused by the extraction of resources for energy purposes cannot be assessed without estimating future activity. A fundamental assumption of these scenarios is that the level of future activities is directly related to the petroleum-resource potential made available for leasing and development. However, industry's interest in exploring for new reserves is influenced by profit motives, where opportunities for new production in northern Alaska must compete with projects elsewhere. Consequently, future development activities and associated impacts are controlled by several factors, including the perceptions of economic potential of the area, the areas available for leasing, industry's ability to identify prospects to drill, and the competitive interest in exploring for new fields.

The scenarios include activities required to develop and produce approximately 88% of the conventionally recoverable oil potential (also referred to as technically recoverable). Commercial gas production may also occur, but most of its environmental manifestations (infrastructure, gravel footprint) will also be part of oil development scenarios. The 1998 Northeast IAP/EIS considered two sets of scenarios: the "first lease sale scenario" and the "multiple lease scenario." Since two lease sales have occurred since 1998 in the planning area, the scenarios presented in this document assume multiple lease sales and full development of the estimated resources within the constraints of each alternative. For the purposes of this analysis it is assumed that current leaseholders in the planning area will adopt the oil and gas leasing stipulations outlined in the ROD for this Supplement, should the ROD select an alternative other than the No Action Alternative.

The projection of the potential extent of future petroleum exploration and development activities differ from those described in the Amended IAP/EIS for the Northeast National Petroleum Reserve-Alaska. Revisions to statements and projections presented in the Amended IAP/EIS were needed to address the intervening rise in the price of oil, to provide an updated description of exploration activity in the Northeast Petroleum Reserve-Alaska (NPR-A), and to provide greater clarity to the reader as to how the projection of reasonably foreseeable oil and gas exploration and development activities was developed. The increase in the price of oil has caused us to take a hard look at how this may affect future oil exploration and development and has resulted in a significantly higher level of projected activity.

II. Description of Typical North Slope Oil and Gas Activities

The following description of oil exploration and development activities reflect common industry practice, particularly in recent years, on Alaska's North Slope. It should be noted, however, that Federal, state, and local regulations, including stipulations and ROPs that may be adopted

through this Supplemental planning process, may limit where, when, under what conditions, and even if these activities may be allowed within the planning area.

A. Petroleum Operations in Arctic Conditions

1. Past Experience

Oil and gas operations have been conducted in the North American Arctic for over 80 years. Early exploration drilling in northern Canada resulted in an oil discovery at Norman Wells in 1920, a field that has produced intermittently since then. The undeveloped Umiat oil field, located in the southeastern portion of the planning area, was discovered during exploration by the U.S. Navy in 1946. The U.S. Navy program also discovered the South Barrow gas field, which began production in 1950 to supply government facilities and the community of Barrow. Extensive exploration in the NPR-A by the Navy, and later by the USDOI (USGS/Husky), ended in the early 1980s.

Exploration efforts in the 1960s resulted in numerous oil and gas discoveries in northern Alaska and in Canada's Mackenzie Delta. The largest of these, the Prudhoe Bay field discovered in 1967, has produced 13 Bbbl of oil. After the completion of TAPS in 1977, a number of oil discoveries on State of Alaska lands on the North Slope fed into TAPS, reaching a peak production rate of 2.0 million barrels per day in 1988. A leasing program in the NPR-A was initiated by BLM in the early 1980s and resumed in 1999 after completion of the 1998 Northeast Final IAP/EIS. The 1994 discovery, and undoubtedly the most important factor in the renewed interest in the planning area, is the Alpine oil field located in the Colville River Delta near the eastern NPR-A boundary. Oil production from the Alpine field began in November 2000 and was producing 115,000 barrels of oil per day (BOPD) by late 2004. Combined production from the original Alpine field (CD1 and CD2) and the two satellite fields (CD3 and CD4) is expected to peak at 135,000 BOPD in late 2007. A "satellite" is a smaller hydrocarbon accumulation that cannot be reached through directional drilling and which cannot economically support separate processing facilities. Therefore, the satellite is a drill site production pad that flows recovered hydrocarbons to a central facility for processing. Additional discoveries in the Northeast NPR-A have also influenced renewed interest in further leasing of NPR-A lands.

Information from decades of experience in Arctic exploration, development, and production is contained in a variety of government and industry reports. No attempt is made here to cite all the historical literature relevant to the NPR-A, but readers are directed to the excellent documentation in the 105 Policy Analysis Reports generated for previous NPR-A leasing (USDOI BLM 1979a, b, c, d); an operational history of government-sponsored exploration in the NPR-A (Gryc 1988, Schindler 1988); the Draft Arctic National Wildlife Refuge (ANWR) Resource Assessment Report for technology and operational aspects of the eastern North Slope (USDOI 1986); the Alpine Environmental Evaluation Document, containing detailed descriptions of current project designs (ARCO Alaska, Inc. 1996); and the Cumulative Environmental Effects of Oil and Gas Activities on Alaska's North Slope report published by the NRC (2003).

2. Technology Advancement

The following discussion is an update of the text previously provided in the 1998 Northeast IAP/EIS (USDOI BLM and MMS 1998) and the Amended IAP/EIS. It is important to recognize that numerous technological advancements have been made during the decades of operations on the North Slope that have allowed current development activities to proceed at a lower cost and

with less environmental impact than operations associated with development at Prudhoe Bay and other North Slope fields developed in the 1970s and 1980s. It has become apparent that lower levels of impact often translate into lower overall development costs. Some of these advancements are listed below, and others will be discussed under subsequent headings of this Supplement, particularly **section 4.7.4**.

- Vehicles involved with seismic operations have been modified to reduce their ground pressure, thereby extending the season for overland travel with minimal impact to the tundra surface. Packed snow trails allow vehicles to move supplies into remote areas.
- Three-dimensional (3-D) seismic surveys and interactive workstations have improved drilling efficiencies, resulting in fewer dry exploration wells, more efficient facility placement, and higher recovery volumes.
- Drilling-pad footprints have been reduced over 80% from older pad designs by using closer wellhead spacing and by eliminating surface mud-reserve pits (tanks have replaced pits).
- Winter ice roads are used instead of permanent gravel roads to move heavy equipment and materials to drill sites. These seasonal roads melt in the summer, leaving minimal impact to the tundra.
- Ice pads are used for winter exploration drilling and airstrips. Some pads have been maintained over the summer, thereby decreasing the time to mobilize rigs for exploration drilling the following winter season.
- Spent drilling fluids and rock cuttings are processed and injected into subsurface disposal wells. Current practices allow no discharge of drilling fluids or dumping of drilling wastes on the land surface.
- Extended-reach drilling can tap reservoir targets miles away from the surface pad. Fewer drilling pads are needed to develop subsurface reservoirs, resulting in a smaller overall footprint for development facilities.
- Portions of a single well bore can be used to produce from multiple lateral legs, thus increasing well productivity and reducing the number of surface wellheads. Fewer wellheads at closer spacing reduce the pad footprint.

A generalized timetable for a typical project in a remote area of the North Slope is presented in Table 4.2-B. Discoveries could be announced at any time within a 10-year period (assumed primary lease term) following the sale. Delineation and development activities usually take from 3 to 6 years after discovery. Production activities continue year-round for 10 to 50 years, depending on field size. Field abandonment, including well plugging and site restoration, can take from 2 to 5 years after production ends. This general timeframe suggests that new oil production from leases in the planning area is not expected for a minimum of 7 to 8 years following a lease sale. Considering the logistics of oil and gas exploration and development, distances between existing operations and potential future operations in the planning area, it is more likely that 10 years or more would pass between a lease sale and the startup of oil production from a newly discovered field. Since the 1999 NPR-A leases were issued, several discoveries of oil have been announced but have yet to be proven commercially viable. Gas production from planning area lease sales would not occur until many years after a transportation system was constructed from the North Slope. Considering the economic and political aspects of future project(s), gas production from the planning area could be delayed several decades. (For an additional discussion of gas development, see subsection II.G in **4.2.1.2.**)

3. *Logistics*

The difficult logistics faced by operations on the North Slope typically result in long delays between leasing and production activities. Other than the basic materials (gravel, water, and fuel), nearly all personnel, equipment, and supplies must be transported to the North Slope from elsewhere in Alaska or outside the state. Heavy equipment, such as production modules, is usually fabricated near ports on the West Coast or in Cook Inlet and then transported thousands of miles to the North Slope by marine barge trains (sealifts). Although this mode of transportation is more economical than other means, sealifts are restricted to a short period during the ice-free summer months. The scheduling of fabrication and delivery of modules by sealift is critical.

Two jet airports and a haul road (the Dalton Highway, beginning 84 miles north of Fairbanks) provide service to the oil-field infrastructure surrounding Prudhoe Bay. Although the airport and haul road are generally open year-round, the type of carrier (aircraft or truck) restricts load capacity, and both road and airports are frequently closed during winter storms.

Today, the North Slope infrastructure offers a variety of supplies and service-industry support. However, all of the materials and supplies needed for planning area operations must move at least 75 miles from the westernmost road-accessible base camp in the Kuparuk River field located west of the Prudhoe Bay field. Overland transportation is relatively open from late December to early May but winter temperatures are extremely cold (sometimes -40°F or colder) and "whiteout" conditions are frequent. The sun is down for 2 months (late November-January). Low-ground-pressure vehicles (Rolligons, sleds) can travel at six to eight miles per hour on frozen tundra. Low-ground-pressure vehicles typically transport equipment, crew facilities, and seismic operations. They are also used to transport drilling rigs that are able to be disassembled into components light enough for transport by these vehicles. (Bruce St. Pierre interview by Jim Ducker, 12/29/06). Ice roads are constructed to move very heavy equipment such as intact drilling rigs and production modules. Heavy equipment typically moves slowly (2 miles per hour) on ice roads or permanent gravel roads.

Remote base camps, which can be established for year-round use, typically consist of facilities housed on gravel pads, which could include existing pads at Inigok and Camp Lonely. These camps contain storage tanks for fuel, warehouses for supplies, housing for personnel, and permanent gravel airstrips capable of handling large capacity aircraft, such as the Hercules C-130. Staging areas located on the coast also are designed as receiving terminals for sealifts. Oliktok, to the east of the planning area, has a dock. There are currently no docks in the planning area. The Lonely Dew-Line station, however, provides high ground which can best be accessed by barge at higher tides. Barges can transport heavy equipment and supplies to coastal staging areas during the short summer months (mid-July to late-September), and materials are stockpiled for operations at remote sites during the winter. In winter months, materials and equipment are moved by temporary roads (ice or packed snow) or by aircraft to exploratory drilling sites. Remoteness is a major factor that adds time and cost to operations in the planning area, compared to similar activities in the Prudhoe Bay area.

Aircraft, both fixed-wing and helicopter, would provide access for oil and gas-related activities throughout the life of any potential oil field. This could include air support for seismic and exploratory drilling activity; aerial surveys and support for ground surveys of wildlife, archaeological, and other resources; road and pipeline route surveys; pipeline inspections; and

support for other development, operations, and abandonment activities. The location, timing, and frequency of such flights and the type of aircraft used will be influenced by the phase of oil exploration, development, and operations, the location of any oil discovered, the type of development that might occur, as well as restrictions that BLM and other regulators might place on the lessee or permittee. While a reliable projection of the number of flights is not possible, the following examples give some indication of the number of flights at different stages of oil and gas exploration and development:

- Commonly at least three summer helicopter surveys for resources (archaeological, lakes, and fish) are required for each exploratory well prior to drilling, and additional trips would be necessary to identify the best access routes and stream crossings.
- In analyzing the impacts of development of five satellite production pads for Alpine, one of which would not be connected by a road, the BLM in 2004 projected that:
    - "non-operational" helicopter flights for such activities as environmental studies and monitoring and travel for important people and government agency personnel may result in 5,000 summer helicopter flights annually;
    - during an approximately six-year construction phase, there would be an average of 45 to 70 one-way operational aircraft flights per month during winter (some months as high as 245 such flights) and 0 to 340 one-way operational flights per month during the summer (some months as high as 615 such flights);
    - during the drilling phase that would occur over the same number of years, there would be approximately 70 to 90 one-way operational flights per month during both summer and winter;
    - once operations began flights would average 8 to as many as 32 flights in winter per month and 8 to as many as 80 flights per month in summer.

Table 4.2-B. Development Timeframe for a Typical Oil Field

Project Phase	Duration of Activity (years)[1]	Activities
Exploration	1 to 10	• conduct seismic surveys to define prospects • conduct well-site surveys and permitting • drill exploration wells
Discovery	Can occur anytime during or after exploration	• drill additional wells to delineation the extent of the hydrocarbon reservoir • conduct additional seismic survey (3-D) • construct hydrocarbon reservoir models • carry out baseline environmental studies, monitoring and survey work.
Design & Permitting	Can occur anytime during or after economic discovery is affirmed and project is sanctioned by lessees	• apply for permits • complete conceptual engineering • complete preliminary engineering • complete detailed engineering • obtain financial approval for project and procure long lead time materials • carry out environmental studies and monitoring
Construction and Transportation to Site	Can occur anytime after Authorization for Expenditures is approved	• obtain permits to construct • fabricate facilities • install roads and marine facilities to access site • build gravel drilling and production facility pads • transport materials and facilities to site • install piping and facilities • continue to carry out environmental studies and monitoring
Development	Normally takes 3 to 6 years past the initial discovery	• obtain drilling, and operational permits • drill disposal wells • establish construction base camp • begin drilling development wells • install pipelines and pump stations • install production facilities and hookup
Production	10 to 50 years post-development	• continue development-well drilling • ramp-up production (2 to 5 years) • reach peak production plateau (3 to 8 years) • expect production declines • well workovers (every 3 to 5 years) • conduct infill drilling (well spacing reduced) • employ tertiary recovery methods • progressively shut in wells • reach an economic limit
Abandonment	Individual wells can take 2 to 5 years	• plug and abandon wells • remove production equipment • dismantle facilities • decommission pipeline • restore and re-vegetate sites • phase out environmental monitoring

B. Exploration

1. Seismic Surveys

Seismic survey work is an integral part of exploration for oil and gas fields. Seismic surveys are authorized on BLM-managed surface by approval of Notices of Intent to Conduct Geophysical Operations. Seismic methods can be used to generate images of the geologic variability between wells. These images can help complete a picture of the subsurface and enhance the ability to successfully identify drilling targets.

Although seismic data has been collected in the NPR-A for decades, collection of additional seismic data is undertaken for several reasons: 1) to capture enhanced subsurface detail through closer seismic line grid spacing (grid pattern); 2) to acquire new data using advanced techniques for better resolution of subtle geologic features and stratigraphy; and 3) to define the limits of the discovered oil pool and to help design efficient development drilling programs. In contrast to early seismic programs that used dynamite in shot holes as the energy source, seismic programs overland and some over water now use vibrator equipment (Vibroseis) to generate energy into the subsurface. This newer technique provides high-quality data with minimal disturbance to the area. In aquatic settings (summer surveys), different survey methods could be used.

2. Seismic Survey Methods

Vibroseis is the standard method for acquiring seismic data on the North Slope, and only occurs in the winter months. The Vibroseis sound source is designed to produce a specific bandwidth of frequencies in a repeatable and consistent fashion. Electronics control a hydraulic system that transmits vibrations through a base plate on the ground. Reflected signals from the subsurface are recorded by arrays of receivers, called geophones, which are installed by hand on the frozen surface of the tundra or frozen water bodies. Vibroseis trucks are typically run in groups of four or five, with their output signals coordinated to generate the energy necessary to record the seismic records to depths of 20,000 feet or more. Returning signals are gathered from the geophone array and processed to tune the seismic data into a coherent representation of the subsurface geology. The Vibroseis technique works best on a hard surface, as a spongy surface does not transmit the output energy very well. Intervening layers (a water layer below a frozen lake surface, for example) degrade both the outgoing and incoming signal for Vibroseis surveys. For these reasons, Vibroseis is not an effective tool for summer conditions on the North Slope or for water bodies where the surface ice layer is not frozen to the seabed or lake bottom.

Seismic surveys also have occurred, and could continue to occur, in deeper bodies of water where Vibroseis surveys are not effective. Collection of seismic reflection data in aquatic areas (ocean, lakes, bays, and lagoons) is commonly accomplished using vessels of varying size during ice-free periods. Typically, one or more airguns are used as a sound source. Airguns, which are deployed behind the seismic vessel, generate a seismic signal by creating a sharp air bubble pulse in the water at intervals on the order of once every 10 seconds. Marine receivers are composed of piezoelectric hydrophones that are contained in long, sealed tubes. Receiver systems can be deployed either as "streamers" that are towed behind a vessel or "cables" that are laid directly on the seabed or lake bottom. Seismic streamers can be several miles in length and are generally used in deeper water where maneuverability is not an issue. Seismic cables (On-Bottom-Cables) are used in shallower water. Both receiver systems contain numerous hydrophones that measure faint pressure signals returning from reflections in the subsurface. To increase sensitivity and cancel out unwanted noise, responses from groups of hydrophones

are summed to produce a single seismogram, thus acting as an antenna to focus faint pressure signals. These seismic data acquisition techniques are generally intended for imaging subsurface depths of several hundred feet to 6 miles. Surveys designed for shallower subsurface depths and higher resolution generally employ lower sound levels and shorter hydrophone systems, while surveys focusing on deep subsurface features employ higher sound sources (usually airgun arrays) and longer hydrophone streamers or On-Bottom-Cables.

Alternatively, seismic surveys have been conducted over frozen lakes using dynamite as the sound source. Shot holes approximately 3 inches in diameter were drilled through the ice and several feet into the lake bottom. Dynamite (or other explosive) charges were installed in boreholes, and geophone receivers were placed on the ice surface. The dynamite charges were then detonated, and reflected energies were recorded by the geophones. Over-ice seismic surveys were conducted in this fashion on Teshekpuk Lake in 1974 and 1975. The approximately 120 line-miles of seismic data that were collected during these surveys are the only seismic data available for large portions of Teshekpuk Lake.

3. Seismic Survey Types

Two types of seismic surveys could be used in the planning area: two-dimensional surveys (2-D seismic) and three-dimensional surveys (3-D seismic). 2-D Surveys involve widely spaced survey lines and are useful for broad reconnaissance survey work and provide a cost effective method for initial data collection. 3-D seismic is typically gathered to improve the quality of the geological and geophysical description of the subsurface hydrocarbon reservoir and trap. 3-D seismic requires a dense grid of seismic lines to provide a more detailed image of the subsurface under the survey area. Seismic data is typically collected prior to drilling an exploration well.

Although 3-D does not remove all exploration risk, it can improve success rates, aid in placing productive wells at optimal locations, and increase the life of a well. Similar energy sources and recording equipment are used for both survey types; however, the density of survey lines, the amount of data collected, and the overall cost of the survey are greater in 3-D surveys. The techniques of setting up geophone arrays and Vibroseis shot points are similar for 2-D and 3-D surveys; however, 3-D surveys are more efficient because the equipment does not have to be moved far between new survey lines. Because of the extra expense, 3-D surveys are generally not used for reconnaissance mapping unless they are essential to map subtle stratigraphic prospects. Therefore, 3-D surveys are most commonly conducted for the delineation of fields, while 2-D surveys are more commonly conducted for reconnaissance.

Typically, three to four seismic crews are active on the North Slope each winter; one to two crews could be expected to collect seismic data in the planning area in future winter seasons. Overland seismic surveys on the North Slope are always collected in the winter when sufficient snow cover and ground frost is present to minimize any damage to the tundra surface. These surveys employ low ground pressure vehicles (soft tracks) to further minimize potential impacts. While the winter operating period can be as long as 5½ months (early December to mid-May), typical seismic operations for an individual survey would last about 100 days.

Mobile camps called "cat trains" support seismic operations and would likely originate from the Kuparuk oil field. Each cat train would consist of 10 (2-D surveys) to 15 (3-D surveys) vehicles, one or more fuel trucks and modular camp units comprising two or three strings of trailers. Each string would have four to eight trailers and would be pulled by a single bulldozer or low-ground-pressure vehicle. Bulldozers, equipped with wide snow tracks, and modular units generally exert greater ground pressure than do the vehicles that run the seismic lines. Seismic

survey equipment has been stored at the Inigok airstrip within the planning area and used in subsequent winter seismic programs. This location is preferable to the Kuparuk oil field because it puts the seismic trains much closer to the area of exploration interest.

Once in the area of operation, camps typically are moved every few days to once a week. The fuel truck or trucks make runs back to a fuel-supply depot, such as the Inigok airfield, through the course of the seismic operation. These fuel runs may occur daily or every few days, depending on a variety of factors, including the size of the operation and weather conditions.

Data collection operations are conducted by all-terrain, low ground-pressure vehicles (both wheel and articulated-track designs). Camp supplies (food, fuel) are transported to the survey area by both ground vehicles and fixed-wing aircraft. Fixed-wing aircraft would support seismic operations. The only summer activities would be reconnaissance by aircraft to prepare for winter surveys. It is expected that seismic crews would be active in the planning area for the foreseeable future.

Following the end of each winter seismic season, each crew would store its equipment at approved staging areas on existing gravel pads. During summer, a repair crew would spend 2 to 4 weeks performing annual maintenance and installing upgrades to seismic equipment. These activities would require aircraft support, with one to two fixed-wing and two to three helicopter flights per week. Upon completion of maintenance work, the crew would leave the equipment at the staging area, and their activity would cease until the following winter. Maintenance operations would be self-contained and use accommodations that were part of the seismic camp. Upon completion of the work, all wastes would be removed and disposed of at approved disposal sites on the North Slope. Disposal of solid wastes would take place in accordance with applicable rules and regulations; none of these activities would require the establishment of new landfill locations. No solid waste would be of disposed on site.

4. Roads and Drilling Pads

Exploratory drilling typically occurs during the winter when conditions facilitate tundra travel and ice road and ice pad construction. Ice roads would provide seasonal routes for heavy equipment and supplies moved to remote staging areas or well locations and are necessary for moving drill rigs. These temporary, seasonal roads are constructed by spreading water pumped from local lakes to build up a rigid surface. Construction of ice roads begins by compacting snow with wheeled front-end loaders and water trucks. If prepacking is authorized, it is done with low-ground-pressure vehicles or various tracked rigs. Typically, ice roads are designed to be a minimum of 6 inches thick and 25 to 35 feet wide, and can be tens of miles long. An ice-road construction crew can build about one mile of road per day and use approximately one million gallons of water per mile of road (CPAI Plan of Exploration – Cassin exploration sites, 2006). Water supplies must be located along the proposed route. New ice-road construction methods, such as using aggregate chips shaved from frozen lakes, substantially decrease both water demands and construction time. For example, under good (very cold) conditions, an ice-road-buildup rate using only liquid water is 1.5 inches per day, whereas using aggregate chips could increase the buildup rate to 4.5 inches per day, with equivalent reduction in the volume of water required. Similar flooding and composite (aggregate chip) methods are employed to construct ice bridges over rivers and lakes. Floating ice bridges are used to cross deep rivers, such as the Colville River.

Snow-packed trails are also constructed and approved for use by low-ground-pressure vehicles and can be used for moving equipment, supplies, personnel accommodations, and drill rigs

capable of disassembly to components small enough for transport on such vehicles. When the tundra is open for early compaction, two vehicles with the least amount of ground pressure (between 1.2 psi and 2.0 psi) are run side by side and follow GPS coordinates along the entire length of the approved snow trail route. After several days of snow capture along the new trail, these vehicles drive the route again to complete the snow compaction process and open the trail for use by other low-ground pressure vehicles that exert less than 4 psi of pressure to the ground. The trail is required to stay within one mile of the authorized route.

Ice pads are used as platforms for drilling winter exploration wells. Ice pads are constructed much like ice roads, with the tundra surface flooded with water to build up progressive layers of ice. As with ice roads, the use of aggregate chips speeds the process while decreasing water demands. A typical ice pad requires about 10 days to construct and is designed to be 1- to 2-feet thick (possibly more depending on topography), cover 6 acres (500 ft. by 500 ft.), and require approximately 5,000,000 gallons of water to construct (500,000 gallons per day) (CPAI Plan of Exploration – Cassin exploration sites, 2006). Depending on the well site, ice pads could range in size from 3 to 10 acres. Water requirements vary, depending on the pad size and availability of aggregate chips shaved from nearby lakes. Seasonal maintenance of ice pads and roads requires approximately 20% of the initial volume of water required to construct the road or pad.

5. *Exploration and Delineation Wells*

It is anticipated that a maximum of eight exploration drill rigs would be available for use in the planning area at any one time. Drilling would be conducted entirely during the winter months (January to mid-April) in most portions of the planning area. Upon completion of drilling operations, all equipment and materials would be removed over ice roads to staging areas and then to other locations on the North Slope, or to recycling centers out of the country. If an exploratory drilling program were to lead to a new field discovery, delineation of the field could take place over 1 to 3 drilling seasons.

Exploration operations require movement of heavy equipment (drilling rigs and camps) and large amounts of materials (steel casing, drilling mud, fuel) to remote locations, which typically occurs on ice roads during the winter months. Approved low-ground pressure vehicles would also be used to transport lighter equipment and personnel to construct ice pads, roads and airstrips via snow-packed trails. Transportation logistics must also allow for regular crew changes and re-supply. An exploration well crew could consist of 30 to 60 people, working 1- to 2-week shifts, who would be transported to the site by aircraft landing on constructed ice runways. Large lakes (1 mile more across) could be prepared quickly as winter landing strips.

Oil and gas companies have used, and are testing, alternative methods to manage exploration and production operations in areas where traditional methods would be limited or challenging because of distance, water availability, or terrain. For example, Phillips Alaska, Inc. obtained permits and successfully left a drilling rig on an insulated ice pad west of Teshekpuk Lake throughout the summer of 2003. This allowed the rig to drill for a longer period of time during the spring of 2003 and to more quickly move to a new ice pad to drill the following winter.

Anadarko field-tested a new drilling system, the Arctic Platform, which has potential for use in the NPR-A, although this is unlikely due to the "pioneering" nature of this technology. The Arctic Platform is like an offshore platform, but is used on land. A self-contained drilling system and crew quarters sit atop a deck made of interlocking modules that rest on pilings set into the permafrost below the tundra. The platform is elevated approximately 12 feet off the tundra, eliminating the need for gravel or ice pads. Surface use of this technology could allow operators

to perform exploration drilling outside the winter season, since ice pads would not be required. This technology could also allow access to remote areas, to areas where water to build ice roads is scarce, and to areas where steep grades make it difficult to set a rig. The Arctic Platform concept may have promise for exploration drilling and as a production unit. At this time, however, it is still in the experimental or developmental stage and, consequently, for the purposes of this analysis, it is assumed that this drilling system will not be used.

Exploration wells in the northern portion of the planning area (the area of highest oil potential) are likely to range from 6,000 to 12,000 feet in depth. For these depths, most exploration wells could be drilled, logged, and tested within a single winter season. If a discovery were made, a second (delineation) well could be drilled from the same ice pad in a single season, depending on well depth and the efficiency of drilling operations.

Modern directional drilling techniques are now routinely used to penetrate one or more small reservoir targets, identified by 3-D seismic, at distances of more than four miles from the drilling location. Application of this extended reach drilling method allows numerous exploration and development wells to be drilled within a radius of nearly five miles from a single drill pad. During the Prudhoe Bay-Kuparuk era, new drill pads, roads and pipelines might have been necessary to drill and develop satellite fields and the costs might have precluded carrying the projects forward. The identified reserves in these fields would have remained in the ground.

To define the limits of reservoirs after a discovery was made, several delineation/confirmation wells would likely be drilled before making a commitment to project development. Additional delineation wells surrounding the discovery well would likely be planned for the following winter or two, and would require new ice pads. Because of high development project costs, two to four successful delineation wells would likely be drilled to establish reservoir continuity over an area. For example, a possible field-development project consisting of two production well pads might require a total of seven wells (one exploration and six delineation wells). Delineation-well drilling would be coordinated with any existing 3-D seismic surveys.

After a well has been drilled, it may be tested for the presence of hydrocarbons. The well can be tested using drill-stem testing equipment, where samples are collected in the wellbore, or by flowing fluids to the surface and through a production separator to measure the amount of oil, gas, and water the well can produce. If testing indicated that hydrocarbons were not present in commercial quantities, the wells would be plugged and abandoned. Cement plugs would be placed throughout the well bore to prevent migration of fluids and gases and to protect subsurface resources. Successful wells (discoveries) could be re-entered for use as production wells at a later time by drilling out the cement plugs, but most exploration wells would be considered expendable and would not be used for later production. If commercially producible hydrocarbons were found, equipment and materials could be left at the site, supported on pilings, to reduce mobilization time the following winter drilling season. Rock cuttings from delineation wells could be either backhauled to existing disposal wells or processed (ground and treated) for subsurface disposal in the abandoned wells. Upon completion of drilling operations, all equipment and materials would be moved back to staging areas on ice roads. No materials or drilling wastes (mud and cuttings) would remain at the site.

6. Water Demand and Rock Cuttings

Drilling operations require large amounts of water to create drilling fluid. Drilling fluid is typically a preparation of water, clay, and chemicals that is circulated into a well during

drilling. The drilling fluid is used to lubricate and cool the bit, transport rock cuttings to the surface, prevent sloughing from the sides of the drill hole, and provide a weighting medium to prevent the migration of oil and other fluids into the well. A 10,000-foot well could require approximately 850,000 gallons of water for drilling, in addition to approximately 100 gallons per day for each person in the drilling crew (for camp use). Approximately 30 to 60 people would be needed to operate a drilling rig. Over a 3 to 4 month drilling season, a one-well drilling operation could require a total of 1,650,000 gallons of water, which would be obtained (if possible) from a source close to the well site. The use of melted snow could supplement this water requirement. Estimated water requirements are much lower for development wells, because 50% or more of the drilling mud would be reconditioned and reused.

A typical 10,000-foot well could use 630 tons of drilling mud and produce 820 tons of rock cuttings. If an exploratory well were to be abandoned, drilling mud and cuttings could be re-injected into an appropriate formation through the borehole. If the well were to be converted to production, it would be temporarily shut in, and the operator would dispose of drilling mud and cuttings at an approved grind and inject facility. No liquid or solid waste would be disposed of on site.

7. *Effects of Shortened Winter Season*

An important concern pertaining to oil and gas operations on the North Slope is that the winter drilling season has been reduced from 208 days in 1970 to 103 days in 2003 as a result of rising global temperature (ACIA, 2004). Because at least 120 days are needed to effectively conduct projects, the shortened seasons result in the need for more drilling seasons, causing projects to take longer to complete. As a result, projects have become more costly in an area already constrained by the high costs of finding and developing oil and gas resources. Because of the shortened season, a growing proportion of the available drilling season is used to build roads, and there is less time to drill wells. Seismic operations are also constrained because shorter seasons reduce the amount of data that can be obtained.

Industry has sought to overcome the shortened winter season through technological innovation. The greater use of low-ground-pressure vehicles and of drilling rigs that can be disassembled into components light enough to be transported on these vehicles have played a role in increasing industry's capabilities despite the shorter winter season. The Arctic Platform described earlier also was designed in part to counter the limitations caused by the shorter drilling season.

C. Discovery and Development

Field delineation and development activities for any particular prospect could take from 4 to 10 years prior to production startup. Production activities would last between 10 and 50 years, depending on the size of the field. Abandonment activities, including well sealing and site restoration, could last 2 to 5 years after the end of production. This representative time frame suggests that new oil production would not be expected for at least 5 years following the lease sale, and it is more likely that 8 to 12 years would elapse before production from leases sold in the next planning area sale would begin. The discovery and development of commercial fields is likely to be staggered over a 10-year period, and petroleum activities could continue for decades after a lease sale.

After a commercial discovery of oil and gas has been confirmed by delineation wells and seismic surveys, a number of construction activities are required to develop a permanent production

operation. A production operation complex would, at a minimum contain a Central Production Facility and production well pad that could potentially support dozens of wells and contain a large production processing facility, an airstrip, camp facilities, and storage yard. An oil-sale pipeline to transport the oil from the area would also be required. Depending on the size of the field or the presence of nearby fields, the production operation complex may also include outlying production pads. These smaller production pads would serve primarily as well pads. A gathering system to the Central Production Facility (CPF) and roads or in some cases an airstrip instead of a road would be needed to these satellite pads. Figure 4-1 shows a reasonable hypothetical layout for a CPF with five satellite fields. Table 4.2-C shows the estimated area of surface disturbance and amount of gravel needed for oil and gas facilities for Figure 4-1. While some satellites, such as two proposed by ConocoPhillips (CD-6 and CD-7), could connect by gravel road to the existing Alpine CPF, we anticipate that development in the planning area would generally not connect by road to areas outside of NPR-A. Winter ice roads or packed snow trails would be used to move heavy equipment and materials from other North Slope oil fields, rather than a permanent gravel road. Fixed-wing aircraft could transport light loads, such as camp supplies and crew changes.

Development and operation of oil facilities in the planning area may require access across the tundra, off pads or gravel or ice roads. Such access could be necessary to respond to spills or other emergencies; conduct training to respond to potential spills; conduct pipeline inspection, maintenance, and repair; facilitate ice road construction; or transport equipment and supplies to oil developments not connected to the interconnected North Slope gravel road network. Vehicles would conduct these activities from the nearest production or processing facility pads or gravel or ice roads (USDOI BLM, 2004b).

1. Staging Areas

Staging areas are used to support exploration, development, and abandonment activities. All materials and equipment necessary to develop a new field must be stockpiled, moved, and assembled in remote portions of the planning area, subject to seasonal constraints for transportation. Consequently, staging areas are very important components to development. Ideally, a staging area contains buildings for warehouses and crew quarters, gravel pads for stockpiling materials, and a serviceable airstrip. Depending on where development occurs, it may also be necessary to develop a staging area on the coast. This would include a causeway or dock for loading materials and equipment transported by barges. For purposes of this Supplement to the Amended IAP/EIS, it is assumed that each staging area would be approximately 50 acres.

Considering the expense to establish a new staging area in a remote site, it may be more cost-effective to reoccupy existing sites, even if some refurbishing is necessary, as was done on private land on the Simpson Peninsula for the 2006 FEX, Inc. winter exploration operations in Northwest NPR-A. Camp Lonely, BLM-administered lands (Cook Inlet Region Incorporated [CIRI] lease site and the DEW-Line site), Inigok, and Umiat have also been used as major staging areas for past NPR-A operations. The DEW-Line site at Camp Lonely is a U.S. Air Force inactive right-of-way. The radar at the site has been removed and no future Air Force missions will originate from there. The site may be acquired by the NSB with the potential for it to be used as a logistic camp for future oil-related activities.

Development of staging areas would occur in winter prior to the start of development activities. The number of barges required in each sealift to support development activities would be up to 30 barges per year. Modules and equipment would be offloaded from barges in 3 to 5 days and

stored on the staging area pad until winter. They would be transported by ice road or snow-packed trail during the winter to the CPF sites. Individual modules could be 20 to 30 feet in height. Each CPF would likely require one or two large sealifts (1 year apart), depending on its size. Modules would eventually become the site's energy generation, operations, and housing facilities complex.

It is likely that the first development operations in the planning area initially would be staged out of existing facilities at the Greater Prudhoe Bay Unit or Kuparuk River Unit. Both of these base camps have all-season airports, are connected by road systems, and have marine loading sites (West Dock and Oliktok Point). Materials and equipment likely would be moved to staging areas within the planning area using marine transport in the summer months and/or by trucks or low-pressure vehicles over ice roads/snow-packed trails in the winter months. Aircraft would access remote sites at all times of the year; however, air traffic would be restricted by low clouds and fog in the summer and by storms with whiteout conditions in the winter.

After the tundra is sufficiently frozen and BLM has authorized tundra travel, ice roads would be constructed to remote development sites. Equipment may, with BLM approval, be transported via snow-packed trails. Earth-moving equipment may then move gravel to the site to establish a construction camp and perhaps a year-round airstrip. Later, drilling equipment and supplies would be moved to the site over ice roads/snow-packed trails. Production equipment (modules) and pipeline-construction materials would be moved during the final stages of development. The overall development phase, from construction of a staging area and remote base camp to production startup, could take 3 to 7 years, depending on the size and location of the new field.

2. Gravel Requirements

Much of the initial work for a new project would involve the construction of gravel pads for wellheads, production and support facilities, roads, and an airstrip. The development area must be level, stable, and elevated above the wet tundra surface. Because the tundra surface is unstable and subject to flooding in summer and ice-jacking forces in winter, pad surfaces are designed to be at least 5 feet above the tundra surface.

Gravel is the preferred material for pad construction. Gravel borrow pits are relatively common east of the Colville River, but gravel is a scarce commodity in the planning area. A variety of alternate strategies could be adopted, including the following:

- Extracting gravel from existing mine sites east of the Colville River;
- Developing new sand and gravel mine sites within the planning area;
- Barging gravel to coastal staging areas;
- Processing bedrock for construction materials;
- Designing alternatives (year-round ice pads; composite all-season pads); and
- Reusing gravel from previous drillsites.

Project plans for new field development in the planning area would depend largely on site-specific conditions and the site location relative to sources of gravel materials.

For permanent production facilities, the preferred pad design is one made up entirely of gravel. However, composite pads are a proven alternative. An all-gravel pad rising 5 feet or more above a wet tundra surface requires 8,000 to 12,000 cubic yards (yd3) per acre of surface footprint (Table 4.2-C). Gravel roads (typically 46-82 feet wide measured at the bottom; with 2:1 slopes)

cover approximately 7.75 acres per mile and require approximately 41,000 yd3 of gravel per mile. Airstrips (typically 100 feet wide and 5,000 feet long) cover approximately 11 acres and could require 110,000 yd3 of gravel. The airstrip could also have an apron and taxiway that could cover another 5 to 8 acres (Alpine Satellite Development Plan EIS, 2004; CPAI Alpine Satellite Development Plan, 2002).

Table 4.2-C. Estimated Area of Surface Disturbance and Amount of Gravel Needed for Oil and Gas Facilities

Facility/Disturbance	Number of Facilities/Miles/ Acres	Total Amount of Impact
Basic Development Complex of 1 CPF and 5 production pads with connecting roads		
Central production facilities (1 pad, road, airstrip[1])	1	100 acres
Production pad (10 acres each)	5	50 acres
Roads to satellite fields (7.5 acres per mile)[2]	50 miles	376 acres
Vertical support members (VSMs;150 per mile)[3]	50 miles	<1 acre
Total acres	N/A	526 acres
Gravel Consumption for Basic Development Complex		
Central production facility (10,000 cubic yards per acre)	100 acres	1 million cubic yards
5 Production pads (10,000 cubic yards per acre)	50 acres	500,000 cubic yards
Roads (41,000 cubic yards per mile)	50 miles	2.1 million cubic yards
Total gravel consumption		3.6 million cubic yards
Estimated gravel pits	1- several	100 acres
Potential Additional Infrastructure/Gravel Consumption		
Staging area (50 acres)[4]	1	500,000 cubic yards
Seawater treatment plant (10 acres)[5]	1	100,000 cubic yards
Ice roads (10 miles per satellite pad)[6]	50 miles	50,000,000 gallons

[1] An airstrip would comprise about 11 acres of a CPF's total.

[2] Assumes that there are 10 miles between each production pad .

[3] A 3-mile in-field pipeline for Alpine has 450 VSMs. U.S. Army Corps of Engineers Alaska District, Permit Evaluation and Decision Document, Alpine Development Project, Colville River 18 (2-960874), p. 3 (February 13, 1998).

[4] If a new development is too far from an existing gravel pad, it may be necessary to build a staging pad. This would add 50 acres to the gravel footprint and 10 acres to the area disturbed by gravel pits.

[5] If a new development occurs in the northwestern part of the planning area, it may be necessary to develop a seawater treatment plant on the coast, rather than depend solely on existing facilities.

[6] Assumes that 10 miles of ice roads are constructed for each production pad and that ice roads are constructed annually for 5 years. Sources: USDOI BLM and MMS (1998, 2003) and USDOI BLM (2004).

Site-specific conditions would dictate the facility requirements and consequent footprint size of new discoveries in the planning area. Small developments with a single production pad and an airstrip could have a footprint of approximately 50 acres. Large developments with multiple pads connected by service roads could have footprints of 200 acres or more. For purposes of this

analysis, it is assumed that a typical development complex would have a footprint of 526 acres. The average gravel requirement for the assumed, typical "complex" is approximately 5.4 million yd3, or about 10,000 yd3 per acre of footprint.

Several types of gravel pads have been used in the planning area. Gravel requirements are reduced substantially by composite pad designs in which the lower portions of pads are built using blended (geotextured) mixtures of sand and silt. This lower lift is overlain by rigid foam (Styrofoam) insulation boards and then covered by a layer (2 feet thick) of clean gravel. Surficial deposits used to form the lower section of a pad are available throughout the planning area, and could be extracted and blended during winter months from borrow areas near the development site. Use of such a design could reduce the overall gravel requirement by 33 to 50%, as compared to use of all-gravel pad designs.

Gravel used for developments in the eastern portion of the planning area could be extracted from existing or to-be-discovered borrow sites and then transported to the development sites by trucks over winter ice roads. The proposed Clover A Mine Site is located in the NPR-A, approximately 10.8 mi southwest of the Alpine Oilfield. The mine site is still in the planning stages as part of the Alpine Satellite Development Project. Preliminary characterization of the material source has been done, but no development has yet occurred in the area. Boreholes drilled in 2001 and 2002 by CPAI confirmed the presence of suitable sand and gravel materials within the proposed mine site limits. Additional geotechnical exploration performed to the north and east of the proposed site in the winter of 2004 indicated that the deposits of suitable sand and gravel material are localized and the proposed site appears to offer the greatest concentration of these deposits in the local vicinity (Alpine Satellite Development Plan EIS – Appendix O, 2004).

For more distant sites in the central and western portion of the planning area, gravel could be mined from existing borrow pits, barged to coastal staging areas, and stockpiled for later transport by trucks over winter ice roads or snow-packed trails. Sand and gravel could also be extracted from new sites within the planning area.

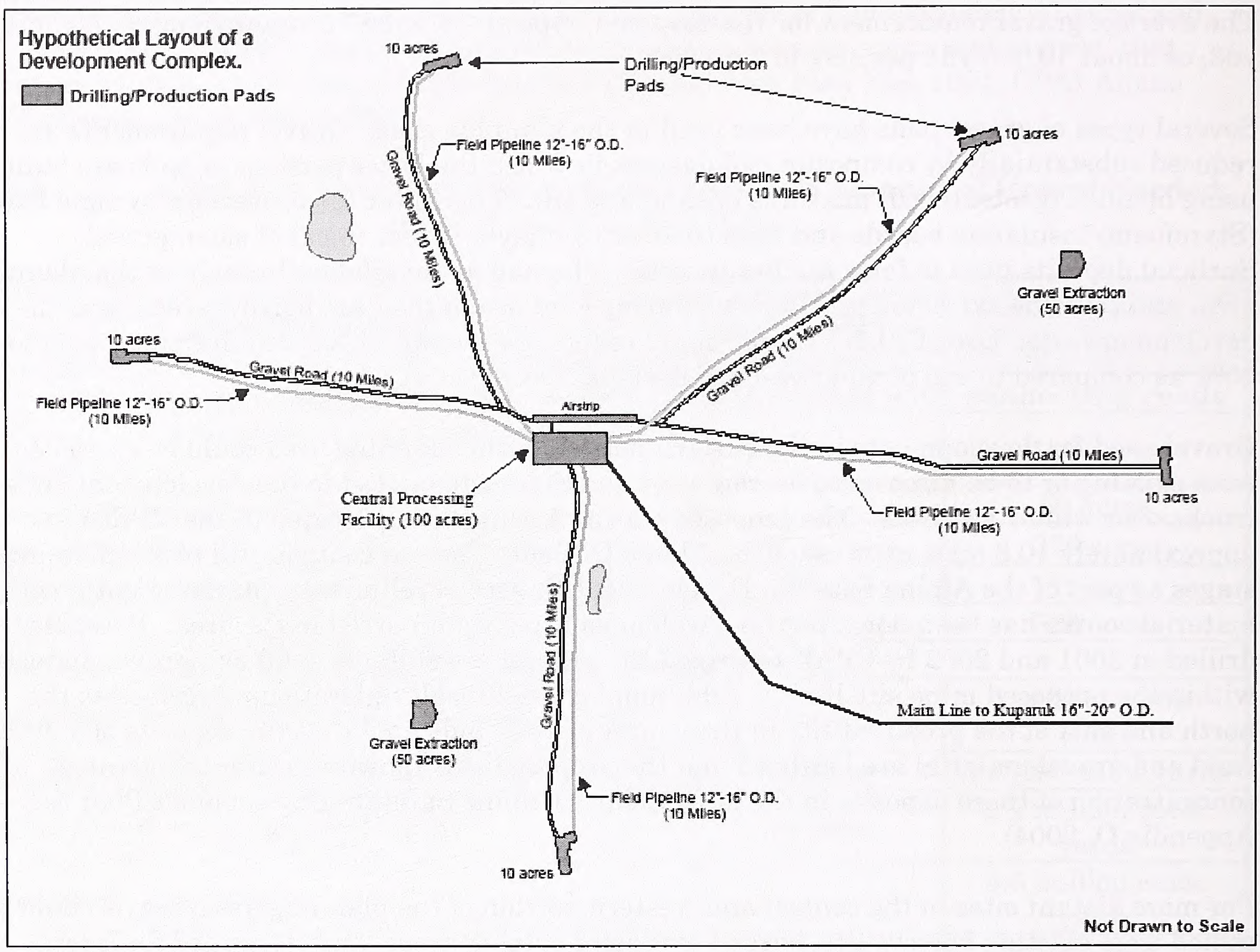

Figure 4-1. Hypothetical Layout for a CPF with Five Satellite Fields.

Previous investigations have identified undeveloped gravel sources in the planning area. It is possible that numerous gravel production sites would be needed. For each new site, overburden removal and sand/gravel mining could impact areas of 20 to 50 acres or more, depending on the thickness and extent of the deposit and amount of material extracted. Between 1988 and 2001, approximately 544 acres of North Slope oil field roads and pads were developed from 104 acres of gravel pits and 19 acres of river gravel removal (NRC, 2003). For this Supplemental IAP/EIS analysis, an assumption was made that approximately one acre would be disturbed for gravel removal to meet the gravel needs for five acres of oil and gas development (e.g., a 10-acre gravel satellite pad would result in two acres of borrow pit disturbance.

Few gravel sources exist for sites in the southern part of the planning area. Surficial gravel sources are rare outside river corridors, so it is likely that alternative materials would be considered. Bedrock outcrops could be blasted and then crushed and blended with sand to make up suitable construction material. Unconsolidated sand and gravel deposits are available in river systems, but restrictions on their extraction are likely. Gravel trucked on long ice roads would add substantially to the cost of developments in the southern portion of the planning area.

3. *Development and Production Well Drilling*

The number of production wells is determined by the unique characteristics of the oil reservoir, such as thickness, permeability, lateral continuity, oil qualities, and, most importantly, the reservoir recover mechanism. Well drainage areas vary, but generally do not exceed 640 acres for gas and 160 acres for oil. Thicker, high-quality reservoirs with high pressure tend to have larger well-drainage areas. Thinner or more laterally discontinuous reservoirs with viscous oil and/or low permeability typically require closer well spacing to achieve effective subsurface drainage. However, horizontal wells with long lateral sections drilled in the reservoir can replace several closely spaced vertical wells.

Virtually all North Slope wells are now drilled using horizontal drilling; a method where the well bore penetrates thousands of feet of reservoir strata horizontally and by doing so increases the reservoir volume exposed to the borehole and production tubing. Production is more efficient and thus less costly. Later in the life cycle of a field, well spacing typically is reduced by infill drilling in the attempt to capture more oil reserves as the pressure in the reservoir is depleted.

In addition to production wells, other wells are drilled to inject water or gas into the field to maximize oil recovery. These wells generally are referred to as service (or injection) wells. Numerous injection wells are required for waterflood programs, which are used routinely throughout the production cycle to maintain reservoir pressure. The proportion of producer to service wells can vary for each field, but a typical ratio of producers to service wells is 2:1 (i.e., one-third of the total number of wells are non-producing service wells).

Multiple pads producing from one reservoir are generally most efficiently spaced at distances of approximately twice the reservoir depth due to the limitations of directional drilling (Alaska DNR, Division of Oil and Gas, Nenana Basin Oil and Gas Exploration License, 2002). Therefore, a reservoir at 8,000 feet requiring two production pads would normally have pads located about 3 miles apart. Assuming an 8,000-foot step-out radius, approximately 4,600 acres (7.2 square miles) could be drained from each pad. If each oil well had a subsurface drainage area of 160 acres, each production pad would hold 29 producer wells and 15 service wells, for a total of 44 wellheads. Extra pad space could be allocated for additional infill production wells. This scenario would be typical should multiple pads be required to maximize production from one reservoir in the planning area.

The time required to drill and complete a production well largely depends on the drilled (or measured) depth of the well. On the North Slope, it normally takes approximately 20 to 30 days to drill and complete a 10,000-foot well, which equates to approximately 10 to 12 wells per rig in a 12-month period. Safety considerations normally restrict operations to one rig drilling on each pad at a time. Using the above example, initial reservoir development drilling operations would take 3 to 4 years to complete. Seasonal restrictions on drilling operations and transportation capacity would increase the overall time to fully develop a field.

Another key consideration is the pressure regime and flow dynamics of oil reservoirs. Once production begins, reservoir dynamics must be carefully managed to optimize oil recovery. Discontinuous production is not an advisable engineering (or economic) practice for oil fields. In addition to lost production, a well may not produce as strongly when brought back on line due to wellbore and/or reservoir damage. A typical shut-in well would require well stimulation which includes the use of chemically modified acids to dissolve many types of scale build up (inorganic mineral deposits). There are also surface facilities concerns such as corrosion and solids (contaminants) buildup within process equipment, deterioration of electrical equipment and

instrumentation, and added costs of facility reactivation. Therefore, ensuring adequate production rates is a factor in well location selection and the timing of drilling activities.

4. *Drilling Mud and Rock Cuttings*

Drilling operations for each development well require large amounts of drilling mud and produce large quantities of rock cuttings. The estimates provided for exploration/delineation wells would apply to development wells of equivalent depths. Based on the design and experience of recent North Slope drilling operations, we anticipate zero surface discharge of wastes in the planning area. Generally, dedicated disposal wells (e.g., approved Class II grind and inject facilities) are used for injection of excess drilling wastes, although it is possible to inject wastes into shallow zones of production wells while allowing oil production from deeper zones. Up to 80% of the drilling mud may be reconditioned and reused, reducing the costs of both materials and disposal.

Generally, all wastewater, spent fluids, and chemicals would be disposed of in injection wells approved by the USEPA or ADEC, depending upon waste characterization. Solid, non-burnable waste would be deposited in large dumpsters or other suitable containers located at each site. These containers would be back-hauled to approved offsite landfills (e.g., NSB landfill at Prudhoe Bay) or taken to an approved incinerator (e.g., the Kuparuk incinerator at the main CPF-1 camp). Normal practices do not allow onsite burial of solid wastes.

5. *Water Demand*

Water is needed for drilling and camp use. Drilling water demand is estimated to be 21,000 to 63,000 gallons per day, or 850,000 or more gallons per well. Water demand is estimated to be 100 gallons per day per person. Potable water demand would drop after 2 to 4 drilling seasons, when the major construction phase would be finished. Approximately 160 persons would be on site during the production and development phases for each CPF and four to six satellite fields (S. Rothwell, ConocoPhillips, pers. Comm.). Drilling-water demand over the 20-year production life of the field (largely for workover operations and infill drilling) would likely be less than the 21,000 gallons per day estimated above.

D. Production

1. *Production Facilities*

A CPF would serve as the operational center for long-term production activities in a North Slope oil field. In addition to oil-production equipment, the CPF typically includes living quarters and offices, maintenance shops, storage tanks for fuel and water, power generators, waste-treatment units, a communications center, and compressors for gas and water reinjection. For most North Slope projects, many components of the CPF are constructed as transportable modules in offsite locations, perhaps outside Alaska, barged to the North Slope, then moved over gravel roads or winter ice roads to the field and assembled. All buildings are supported above the ground on pilings to accommodate ground settling or frost heaving. An airstrip usually is located near the CPF to allow transport of supplies and personnel to the field site.

The CPF typically is located on the largest and most central, or initial, development pad. Equipment at the CPF is used to separate the materials that are produced from the wells (oil, natural gas, and water) on the pad. The CPF would likely process produced oil and gas from smaller, outlying satellite pads as well. Produced oil is filtered (to remove sand) and processed

(to remove water and gas) before being piped through a sales meter and into the sales-oil pipeline system. Gas is processed (to remove liquids and impurities), pressurized (compressed), and re-injected into the reservoir through gas injection wells. Likewise, water is processed (chemically treated) and then re-injected into the reservoir for pressure maintenance.

Re-injection of produced gas and water helps maintain reservoir energy, and improve hydrocarbon recovery efficiency by sweeping oil towards the production wells, increasing the ultimate oil recovery. On the North Slope, gas and water injection wells are needed at the start of production operations, because there is no gas sales line, so the gas must be re-injected into the reservoir, and water disposal is not allowed at the surface, therefore it must be disposed via deep well injection.

2. *Production Rates*

Because development well drilling occurs over several years, the production profile for a field is much broader than for any individual well within a field. Initial production usually occurs when sufficient volumes of oil or gas are achieved to effectively operate conditioning equipment. The production profile would typically increase to peak production volumes as additional development wells are drilled and completed. Production rates typically peak after several years, and may remain at this level for many years, depending on production handling design, future satellite field discoveries, reservoir and well performance, and other factors. Production rates would ultimately taper off from a single field as the reservoir pressure is depleted and the recoverable oil is produced.

3. *Waterflooding*

During production, waterflooding would constitute the major water demand. Waterflooding is a key secondary production practice that can substantially increase oil recovery. Injecting water into selected areas of the reservoir maintains subsurface pressure and promotes fluid flow to the production wells. To maintain reservoir pressure, the volume of oil withdrawn from the reservoir must be replaced with an equivalent or greater volume of water. Therefore, pressure maintenance requires large quantities of water. For example, a field with a daily production rate of 50,000 bbl of oil would require approximately 2 million gallons per day of water (1 bbl = 42 gallons) for balanced waterflooding, given that some volumetric allowances must be made for each fluid under subsurface conditions. At this example production rate, a waterflood program would require approximately 760 million gallons (2,352 acre-feet) of water each year.

To meet waterflood demands, potential sources of water could include nearby deep lakes. Normally, there are restrictions to withdrawals from surface water sources that are vital to fish and waterfowl. Water wells could also be drilled below the permafrost layer (up to 1,500 feet thick) and water pumped from subsurface aquifers, but this practice is costly.

If local freshwater sources are inadequate to meet the demands of waterflood programs, seawater is used. Seawater supplies are virtually unlimited, and unlike freshwater, which must be treated so that it is chemically compatible with the formation into which it is injected, seawater is reasonably compatible (similar chemically) to the brines present in most petroleum reservoirs. Waterflood systems may include a seawater-intake and treatment plant located on the coast and an insulated pipeline from the seawater plant to service wells in the field. Waterflood programs using seawater are initiated from the onset of production for most North Slope oil fields. As the oil field is produced, the volumes of formation water recovered with oil (water cut) increases. In time (5 to 7 years), injection water demands are met by produced

formation water, and the seawater-waterflood system is shut down. Seawater from the treatment plant can then be used for the next field's waterflood program.

New oil fields in the northeastern portion of the planning area might receive seawater for waterflooding programs from existing facilities that currently serve fields in the Prudhoe Bay and Kuparuk River Unit areas but it is possible that a new seawater treatment facility may be needed. Seawater pipelines would be installed on vertical support member (VSM) pipeline supports that would also hold sales-oil and service pipelines. For areas farther to the west, seawater intake and treatment plants would likely be fabricated on barges and moved into temporary locations along the coast. Because the ability to incorporate waterflooding as a reservoir management strategy greatly improves recovery efficiency, the economics of fields discovered near the coastline could be improved due to the proximity of available seawater. However, the value of increased oil recovery would be balanced against the increased costs of seawater-treatment facilities and temporary overland pipelines. With increasing distances inland, expensive heat generators and pump stations could be required to deliver treated seawater to remote fields in the severely cold winter temperatures of the North Slope. Small or very remote fields may not be able to justify the costs of startup waterflood programs and would rely entirely on later waterflooding using produced formation water.

4. *Miscible Injection*

In addition to waterflooding, miscible fluid injection is used to increase the recovery of oil and maintain pressure in the reservoir. Miscible injection involves the injection of various types of gases (generally under high-pressure conditions) into the reservoir. The injected gases can include liquefied petroleum gas (LPG), methane, hydrocarbon gas mixtures, nitrogen, and $CO2$. Hydrocarbon gases are primarily used on the North Slope because they are produced along with conventional oil and therefore readily available. Lack of markets makes re-injection the best use and conservation of the commodity, since a portion of the re-injected gas would be available for future production and sales. Miscible injection is most commonly referred to as Enhanced Oil Recovery (EOR). Miscible injectant may also be injected alternating with water in a single injection well (water-alternating-gas injection or WAG).

E. Abandonment

At some time in the life cycle of a field, the revenue from production is insufficient to justify the expenses of operation. The end of economic life occurs before all of the recoverable oil is extracted from the reservoir. The factors leading to a decision to abandon a field could differ for each field, but declining production rates and oil price are usually the two key considerations.

Wells are plugged and abandoned as the field matures. Abandonment operations generally include removing all equipment, plugging all wells, restoring the site, cutting well casing at least 3 feet below the surface, and conducting final environmental studies. Gravel and gravel/sand pads may or may not be removed, depending on such factors as the impacts of removal, future use values, and the need to recycle and re-use gravel for ongoing projects. Reclaimed or abandoned pad sites may be revegetated with native species, or revegetated with species that would ultimately be replaced by native vegetation or allowed to bed naturally. Abandonment operations could take place over many years, as revegetation and environmental monitoring studies would continue to document the long-term effects of past operations at a particular site. A series of permitting and inspection activities would be associated with oil field abandonment, and would involve visiting the site as needed until satisfactory revegetation occurred.

BLM's overall restoration goal for the NPR-A after oil production ceases is to return it to its previous condition and use, which largely includes fish and wildlife habitat. Abandonment and reclamation activities within NPR-A are governed by 43 CFR Part 3160, subpart 3162, which requires lessees to reclaim the land in accordance with plans approved by BLM (43 CFR §§ 3162.3-4 and 3162.5-1). Additionally, under all alternatives lease stipulations require the lessee, upon conclusion of operations, to remove facilities and rehabilitate the land (Lease Stipulation 58 under Alternative A; Lease Stipulation G-1 under Alternatives B, C and D). All costs associated with abandonment and reclamation are the responsibility of the lessee. BLM regulations require NPR-A lessees to provide financial assurance, in the form of bonds, to assure compliance with all lease terms, including abandonment and reclamation provisions (43 CFR Part 3130, subpart 3134).

F. Transportation

1. Regional Oil Transportation

A regional oil-transportation system for the North Slope oil fields was established in 1977 upon completion of the TAPS. Oil is transported some 800 miles through a 48-inch pipeline to the ice-free port of Valdez, Alaska. From the storage and marine loading terminal at Valdez, oil is loaded onto tankers and transported to U.S. and foreign markets.

The throughput capacity of the TAPS pipeline is a vital factor to North Slope development. The maximum daily throughput capacity of TAPS is slightly over 2.0 million barrels (MMbbl) per day (achieved in 1988). Currently, TAPS throughput is about 800,000 bbl per day (Alyeska Pipeline 2006). The minimum throughput for a viable TAPS operation has been widely debated by government and industry. The common perception is that a minimum throughput of between 300,000 and 500,000 bbl/day represents a realistic mechanical and economic limit to operation. When this minimum throughput rate would be reached is also speculative, because it is difficult to accurately predict the size and timing of new oil field development on the North Slope. However, based on the declining production trends of existing North Slope fields, and assuming no changes to economic conditions or discovery of major new oil fields, the operational limits of TAPS could be reached within the next 20 years. Industry is well aware of this future problem, and aggressive efforts are underway by North Slope producers to reverse the production decline trend by exploring for new fields and using innovative methods to develop marginal fields. Renewed industry interest in the planning area is an important strategy to maintain the throughput of TAPS within acceptable limits. Without this vital transportation system, continued production from the North Slope is unlikely. All NPR-A development scenarios assume that TAPS would continue to operate and carry North Slope oil production.

2. North Slope Pipelines

The central portion of the North Slope contains numerous oil fields connected by pipeline gathering systems to TAPS Pump Station Number 1 (Map 3-2). Because of its location, most new oil development projects in the NPR-A would use the main line between the Kuparuk River Unit and TAPS Pump Station Number 1. The 24-inch Kuparuk River Unit (KRU) pipeline has a capacity of approximately 350,000 bbl/day. Excess pipeline capacity could be used by newly developed fields as large fields feeding this pipeline such as Kuparuk and Milne Point decline in production. For the purposes of analysis in this Supplement to the Amended IAP/EIS, it is assumed that if development occurred in the planning area a new pipeline would be constructed from the planning area to the Alpine oil field, and would then connect to the Kuparuk River

Unit. This pipeline would likely follow existing pipeline or road right-of-ways and would result in little new surface disturbance (see Table 4.2-G).

Oil production from satellite fields, in addition to water handling and gas re-injection capabilities at the Alpine oil field production facility, have the potential to affect the timing of development of future discoveries in the NPR-A should a new pipeline following the Alpine to KRU right-of-way not be built. Originally, peak oil production at the Alpine field was expected to last for 3 to 5 years after startup (Nov. 2000), with production rates declining to about half of peak rate in 15 years. Recent developments and future development of current proposals at Alpine field satellite fields will delay the originally anticipated production decline. ConocoPhillips Alaska, Inc. has completed two of three phases to increase the handling capacity of the production facilities at the Alpine field to 140,000 BOPD (CPAI Annual Report, 2005), but has not announced a proposal to increase the pipeline carrying capacity from the Alpine field to the Kuparuk River Unit pipeline. Consequently, the initial production from NPR-A discoveries may be delayed after discovery unless additional pipeline capacity is added to the existing Alpine oil field.

3. Future National Petroleum Reserve – Alaska Pipelines

The actual locations of new pipelines in the planning area would depend on the location and sequence of commercial-sized discoveries. At present, there is no reliable way of predicting where or when new commercial fields would be discovered and developed. Fields developed early in the future development cycle could establish the first pipeline corridors connecting new planning area fields to existing infrastructure east of the Colville River. Fields developed later in the cycle would be likely to use the existing pipelines, should capacity be available. If large fields were discovered late in the exploration sequence, new sales-oil pipelines could be built. It is possible that commercial-sized fields discovered by different companies would be shut in (i.e., not produced) until an agreement was reached to share the costs of constructing a pipeline system through the planning area.

The diameters and lengths of new pipelines in the planning area would depend on the characteristics of new fields (undiscovered at present) and the resource-development scenarios for each leasing alternative (Figure 4-1). Generally, infield pipelines (flowlines) carry multi-phase slurries (oil, gas, water) from wellhead manifolds to CPFs. Return lines containing gas or water would carry these substances back to injection wells on production pads. Infield flowlines would be relatively small in diameter (4 to 10 inches). Somewhat larger sales-oil pipelines (12 to 16 inches) would carry metered sales-quality oil from individual fields to a centrally located main line (16 to 20 inches). This main pipeline would then connect several producing fields to the Kuparuk River Unit pipeline (24 inches) and then on to TAPS (48 inches).

Based solely on geologic play potential, Figure 4-2 represents speculative pipeline corridors in the NPR-A. No implications regarding specific hydrocarbon prospect location is intended as the actual location of undiscovered commercial-sized reservoirs and the timing of their discoveries is not possible to predict. These hypothetical pipeline corridors represent only one scenario of future NPR-A infrastructure, and more specific discussions on the locations of future development would be misleading.

4. *Pipeline Construction*

Pipeline construction techniques have evolved over decades of experience in the Arctic environment on the North Slope. The following assumptions about the general engineering for pipeline design and construction would apply to future NPR-A projects.

Pipelines crossing large rivers, such as the Colville River, could be buried using horizontal directional drilling techniques similar to those used to drill for oil at the Alpine oil field. Elevated pipelines would likely cross narrow streams to minimize impacts to stream banks and riparian vegetation and to avoid potential problems associated with corrosion, maintenance, and abandonment of buried pipelines. It has been determined that the construction of a bridge over the Colville River would be expensive. Nonetheless, construction of a bridge over the river was recently analyzed in the *Alpine Satellite Development EIS* (USDOI BLM 2004c).

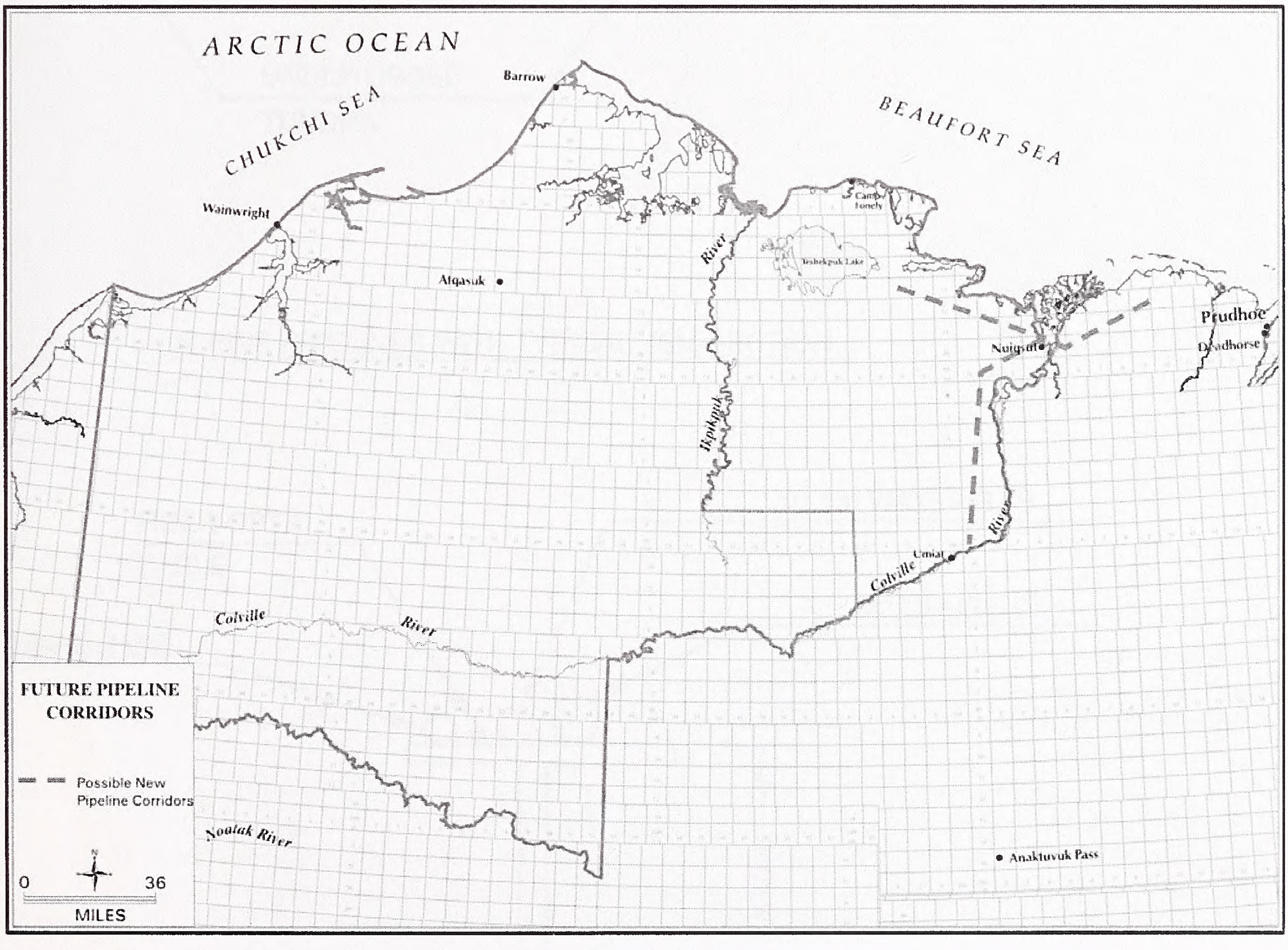

Figure 4-2. Speculative Future Pipeline Corridors

- Relatively wide, shallow rivers could be crossed by trenching and burying insulated pipelines in the riverbed. These pipelines would be installed during winter at locations selected to minimize disturbance to overwintering fish habitat.
- Narrow streams could be crossed by elevated pipelines on suspension spans, as fewer impacts would occur to the stream, streambanks, riparian habitat, and aquatic resources if a properly designed elevated pipeline crossing were to be used.
- Pipeline alignments would be routed to avoid crossing lakes.

- Pump stations could be required along the new mainline route, depending on distances, pipeline diameters, and production rates.
- Future pipeline routes and installation designs would depend on site-specific conditions evaluated by preconstruction engineering studies.

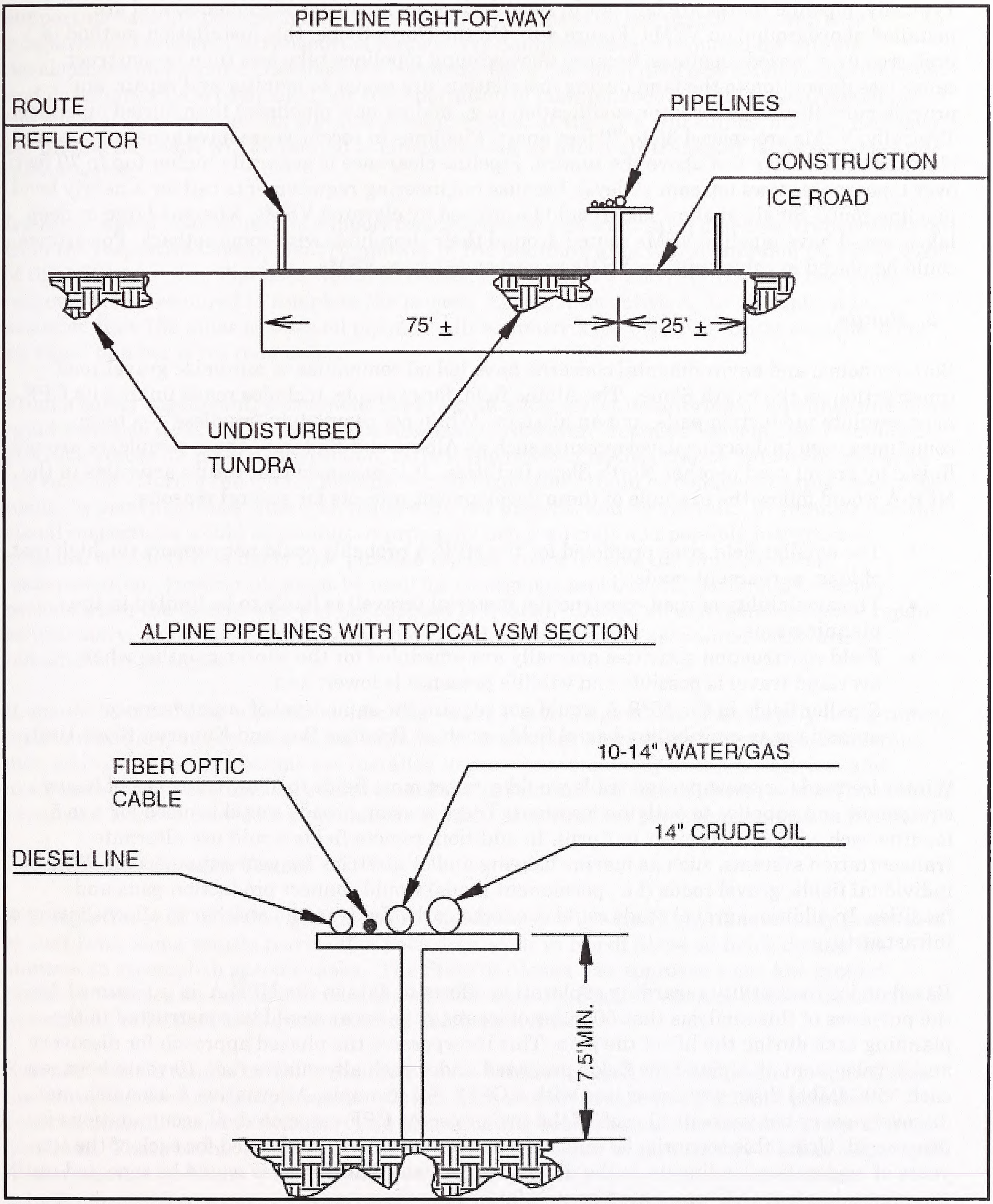

Figure 4-3. Sample Pipeline Layout

Typically, pipeline routes are laid out in straight-line segments (or alignments) and are installed aboveground on VSMs (Figure 4-3). On the North Slope, this installation method is preferred over buried pipelines, because aboveground pipelines take less time to construct, cause less disruption to the land during installation, are easier to monitor and repair, and provide more flexibility for later modification (e.g., adding new pipelines) than buried pipelines. Typically, VSMs are spaced 35 to 70 feet apart. Pipelines in recent years have generally been elevated at least five feet above the tundra. Pipeline clearance is generally higher (up to 20 feet) over topographic lows (stream valleys), because engineering requirements call for a nearly level pipeline route. Small, shallow lakes could be crossed by elevated VSMs, whereas large or deep lakes would have pipeline VSMs routed around their shorelines with some setback. Powerlines could be placed in cable trays on VSMs or suspended from VSMs.

5. *Roads*

Both economic and environmental concerns have led oil companies to minimize gravel road construction on the North Slope. The Alpine field, for example, includes roads linking its CPF, most satellite production pads, and an airstrip. While not completely "roadless"—a term sometimes used to describe developments such as Alpine and Badami—these complexes are not linked by gravel road to other North Slope facilities. It is assumed that future activities in the NPR-A would follow the example of these development projects for several reasons:

- The smaller field sizes predicted for the NPR-A probably could not support the high cost of long, permanent roads;
- The availability of road-construction material (gravel) is likely to be limited in the planning area;
- Field construction activities normally are scheduled for the winter months, when overland travel is possible and wildlife presence is lower; and
- Smaller fields in the NPR-A would not require the same level of supply/service operations as multibillion-barrel fields, such as Prudhoe Bay and Kuparuk River Unit.

Winter ice roads or snow-packed trails would connect most fields to allow transport of heavy equipment and supplies to outlying locations. These seasonal roads would be used for 4 to 5 months each winter (December to April). In addition, remote fields would use alternate transportation systems, such as marine barging and/or airstrips for year-round access. Within individual fields, gravel roads (i.e., permanent roads) would connect production pads and facilities. In addition, gravel roads could connect nearby fields to one another to allow sharing of infrastructure.

Based on ice road utility regarding exploration efforts to date in the NPR-A, it is assumed for the purposes of this analysis that 50 miles of ice roads per year would be constructed in the planning area during the life of the plan. This incorporates the phased approach for discovery and development of Alpine-type fields projected under each alternative (i.e., 10 years between each 350 MMbbl discovery associated with a CPF). For example, Alternative A assumes one discovery every ten years until each of the five projected CPF-associated oil accumulations is discovered. Using this scenario, 50 miles of ice roads would be constructed for each of the ten years of exploration leading up to the discovery of a field. This scenario would be repeated until the remaining four CPF-associated accumulations are discovered.

Following a 350 MMbbl-sized discovery, and during the development of the main field and projected satellite fields, it is assumed that 50 miles of ice roads are constructed annually for ten years from the nearest permanent gravel road to each Central Processing Facility

supporting satellite development. This assumption is based on the practicality and cost comparisons between air transport of large/heavy equipment loads required for satellite development and ground transport via ice roads. Once the main field and satellite construction and development are completed, air transportation of maintenance equipment and personnel to the development complex via a gravel airstrip located at the CPF will suffice, and the necessity of building ice roads will be limited to circumstances in which air transport is not feasible or cost-effective.

Ice roads would also be used to support construction of projected sales pipelines transporting oil from the respective development complexes in the planning area to transmission pipelines east of the NPR-A border. Pipelines would be constructed in winter and it is assumed two winter seasons will be required to complete the project. Under Alternative A, for example, it is assumed that 162 miles of sales oil pipeline will be constructed over two winter seasons using an equal number of ice road miles.

From a safety standpoint, permanent roads would allow direct monitoring of pipelines and more rapid response time, should repairs be necessary. However, "roadless" development would not preclude access for pipeline inspection; rather, the mode of transportation would change with the seasons. During the winter months, visual inspections could be conducted using nearby ice roads, by snowmachines where ice roads were not present, and by aircraft. In summer months, visual inspections would be conducted primarily using aircraft and possibly low-ground-pressure vehicles. It is likely that pipeline repairs would involve the same forms of transportation. Hovercraft might be used for emergency repair work, particularly during periods when the tundra was wet (as opposed to frozen). Should an emergency pipeline repair be necessary, an on-site coordinator would consider the tradeoffs associated with various remediation strategies.

It should be noted that pipeline monitoring on the North Slope is now done largely using remote instrumentation, and in some cases with use of smart pigs and maintenance pigs. Numerous monitoring and safety systems are installed to provide redundancy in these electrical and mechanical safety systems. In addition, mechanical shutoff valves are being replaced by vertical expansion loops to provide a more failsafe method of controlling pipeline pressures and leaks.

6. *Summer Tundra Travel*

Although travel off of gravel pads is easiest in winter and generally environmentally preferable at that time, some vehicle travel off of pads does occur in North Slope oil fields during the summer to accomplish specific tasks. The State of Alaska has approved some low-ground-pressure vehicles for summer tundra travel after July 15. Similar summer tundra travel may be anticipated to be part of oil production in Northeast NPR-A.

Summer vehicle tundra travel is commonly associated with spill prevention and preparedness measures required in spill prevention plans. Each summer season, low-ground-pressure vehicles might be used to transport and place floating booms across streams downstream from pipelines. These booms are left in place through the summer to capture any oil that might spill from a pipeline and then would be retrieved, again probably using low-ground-pressure vehicles, before freeze-up. Pipeline inspections may also entail summer vehicle travel on the tundra. Finally, periodically spill response training may occur along and downstream from pipelines in summer.

G. Gas Development

The above description of oil and gas development has focused on producing commercial oil. To date sale of gas in NPR-A and elsewhere on the North Slope has been precluded by a lack of a transportation system to transport the gas to market. Even if a gas pipeline is built to take North Slope gas to market within the next decade, gas production for sale from NPR-A may still only occur decades hence. It is estimated that there are 35 Tcf of onshore discovered gas available on the North Slope, much of it associated with existing oil infrastructure. This discovered gas alone would be capable of keeping a gas pipeline, such as the ANGTS or one contemplated by the North Slope oil and gas leaseholders, operating at full capacity for approximately 20 years. (ADNR, 2004d; Fisk and Hinnah, 2005) The National Research Council in 2003 reported estimates of an additional 72 Tcf of undiscovered onshore and 97 Tcf of undiscovered offshore gas; much of it would also be closer to existing infrastructure than gas in NPR-A. While economics will dictate corporate strategies, there is good reason to believe that the availability of these other large gas resources would mean that commercial gas development in NPR-A may be decades into the future.

Oil production will continue to be the primary focus of energy extraction from NPR-A and northern Alaska in general. MMS/BLM's geologic analysis in 2002, however, indicates the Northeast and Northwest NPR-A planning areas combined could contain a mean undiscovered technically recoverable gas endowment of 37.3 Tcf. The NPR-A generally becomes more gas prone toward its western and southern areas. However, the richest oil play (Beaufortian-Barrow Arch) in both Northeast and Northwest NPR-A contains a large portion of the undiscovered gas in Petroleum Reserve and approximately 97.5% of all conventionally recoverable gas in the planning area is in plays that also contain oil. Consequently, it is likely that if gas is produced for market in NPR-A it will come from fields with a substantial oil component and be developed in conjunction with oil (USDOI BLM and MMS, 2003).

Gas would arrive at a CPF from production pads in the same pipelines mounted on VSM that carry oil to the CPF. It would be separated from the oil and water at the CPF, compressed, and cooled before entering a buried pipeline to make its way to the northern terminus of a gas line in the Prudhoe Bay area. The buried gas pipeline would parallel the sales oil pipeline, offset by approximately 75 to 100 feet. The gas would be chilled at the CPF to a temperature that is equal to the mean annual ground temperature. This is intended not just to prevent melting of the permafrost along the pipeline but also to avoid any changes of the thermal regime of the in situ soil. This is important to prevent long-term moisture migration, ice formation, and ice inclusions from forming in the soil around the pipeline. (ADNR, 2006)

The most likely design would be for gas pipelines to be buried so that the top of the pipe is about 30 inches below grade (ADNR, 2006) in trenches approximately 5 feet deep and 4 feet wide, with a surface disturbed area 15 feet wide along the length of the pipeline route. Pipeline burial depth, however, may need to be deeper to assure that pipeline is not affected by thawing. Depending on the throughput and other factors of pipeline design, stations for compressing and cooling the gas would be built at regular intervals (60 to 100 miles) along the route of the underground pipeline to maintain optimum operating conditions. The footprint of the compressor station would consist of a 10- to 20-acre pad, depending on the design of the facilities. It is possible that compressor stations would also be connected to pipelines from other CPFs or satellites. For this analysis, it is assumed that in time market gas would be transported from each CPF, gas pipelines would be equal in length to the sales oil pipeline for each alternative, and that for each alternative there would be one compressor on each CPF and one compressor station that would not be on a CPF.

Burial of natural gas pipelines is desirable for both safety and operational reasons. High-pressure gas lines pose a risk of rupture and explosion. Burial and offset from the oil pipeline mitigate the potential impacts if a gas explosion were to occur. High-pressure gas lines operate more efficiently when chilled, and permafrost is a good material in which to install dense-phase, high pressure gas pipelines that entrain natural gas liquids. River crossing methods would be determined by characteristics of the river; where elevated spans would be used across narrow, deep rivers, burial in trenches is likely to be used across wide, shallow rivers, and horizontally-drilled tunnels could be used across wide, deep rivers.

The State of Alaska, however, in its study of a potential gas pipeline near the coast east of Prudhoe Bay, considered both a buried gas pipeline and one that would be elevated on VSMs. The state considered an above-ground gas pipeline more appropriate for low-volume gas pipelines and in cases in which burial created hydrologic challenges in crossing many drainages. (ADNR, 2006; Thompson, 2007) If an aboveground gas line was constructed in the planning area, it is assumed that it would either be placed on the same VSMs as a sales oil pipeline or on a separate set of VSMs. To minimize caribou movement disruption, an aboveground gas pipeline on a separate set of VSMs would be separated from any other set of VSMs by at least 500 feet and be elevated the same height as an oil pipeline; i.e., 5 feet under Alternative A and 7 feet under the other alternatives.

Construction of a gas pipeline would occur in winter. It would utilize ice roads for heavy equipment. In addition to the ice road and the 4-foot-wide trench, approximately another 11-feet-wide area along the length of a buried gas pipeline could receive impacts from soil compression, vegetative disturbance, and temporary placement and incomplete removal of backfill. These impacts would be greatly mitigated by winter construction. Planned maintenance also would likely occur in winter.

III. Petroleum Resource Estimates

Estimates of oil and gas resources provide the basis for identifying areas for possible future leasing and projecting reasonably foreseeable exploration and development scenarios analyzed in environmental impact studies. The NEPA process requires reasonably foreseeable consequences of the proposed action be considered.

Estimates of undiscovered resources are uncertain for geologic, engineering, and economic reasons. Geologic data are in a nearly constant state of revision, as new concepts are revealed by detailed studies, mapping, and new well information. Engineering evolves with new technology and experience. Economic conditions, such as oil and gas prices, are difficult to predict beyond the near future.

Two resource assessments were completed for NPR-A in 2002. The first, conducted by the U.S. Geological Survey (USGS), assessed oil resources in the entire NPR-A, including the Northeast, Northwest, and South Planning Areas (Bird and Houseknecht, 2002a and 2002b). However, the USGS assessment did not provide resource estimates broken down specifically by each individual planning area. Accordingly, MMS and BLM independently performed a joint assessment of the oil resource potential of the Northeast and Northwest NPR-A Planning Areas in support of environmental studies of the impacts of proposed leasing programs for these two planning areas, a discussion of which is presented in Appendix 7 of the Northwest IAP/EIS (USDOI BLM and MMS, 2003). Comparison of the two assessments is complicated by their differing geographic scopes, in that the USGS assessment addressed resources in the South

NPR-A Planning Area, in addition to the Northeast and Northwest Planning Areas covered by the MMS and BLM assessment. However, the results and conclusions of the two assessments were very similar.

The USGS assessment concluded that the Federal lands in the entire NPR-A contain between 5.9 and 13.2 Bbbl of conventionally recoverable oil, with a risked mean of 9.3 Bbbl, and that about 80% of these amounts were likely to occur in northern NPR-A across the northern and eastern portions of the Northeast and Northwest Planning Areas. Similarly, the MMS and BLM assessment concluded that the Federal lands in the Northeast and Northwest Planning Areas of NPR-A combined contain between 6.8 and 11.8 Bbbl of conventionally recoverable oil, with a risked mean of 9.1 Bbbl, and also that, as with the USGS assessment, the great majority of this oil was likely to occur across the northern and eastern portions of the Northeast and Northwest NPR-A Planning Areas. The similarity of the assessments is further demonstrated by the fact that only a very small amount of the 9.3 Bbbl of oil estimated by the USGS is attributable to the southern portions of NPR-A, primarily comprising the South NPR-A planning area. Thus, the conclusions in the two assessments regarding the mean amount of conventionally recoverable oil are nearly identical when one accounts for the minimal amount of additional oil estimated by USGS to be contained in the southern portions of NPR-A.

Conventionally recoverable oil refers to oil resources recoverable by current technology, processes and knowledge and without regard to economic feasibility or environmental constraints. The conventionally recoverable oil resource serves as the maximum theoretical limit for production. Engineering, economic, and environmental factors are included in evaluating the commercial viability of oil and gas prospects. When economic realities are considered, the amount of resources expected to be leased and commercially produced is lower than the geologic potential. Such economic considerations are primarily driven by the price of oil and cost of oil and gas operations. In this sense, oil companies tend to base their leasing, exploration, and development decisions on their predictions of future oil prices and operational costs throughout the life of a potential project, with predicted higher oil prices and lower costs tending to result in the pursuit of prospects that would not otherwise have been pursued given lower oil prices and higher costs.

Accordingly, after estimating the amount of conventionally recoverable oil, each of the two assessments additionally evaluated the quantities of oil that were economically recoverable at various future prices of oil assuming a typical level of operational costs. For example, at about $30 per barrel both assessments concluded that about 5.6 Bbbl of oil would be economically recoverable from their respective study areas; whereas at $40 per barrel, the USGS assessment concluded that about 6.9 of its 9.1 Bbbl of oil was most likely to be economically recoverable, compared to the finding in the MMS and BLM assessment that approximately 7.4 of its 9.3 Bbbl of oil was likely to be economically recoverable. While the USGS assessment did not consider oil prices above $40 per barrel, the MMS and BLM assessment did and demonstrated that approximately 8.0 Bbbl of oil would be economically recoverable at prices near $50 per barrel.

Each of the assessments reflects the basic principle that increasing volumes of oil can be recovered profitably as the price of oil rises. However, such increases are not limitless. As price rises, oil production becomes progressively more inelastic until ultimately a point is reached where further price increases result in little or no additional production. It is difficult to predict with reasonable accuracy where this point occurs based on the USGS assessment since it did not evaluate prices above $40 per barrel. However, the MMS and BLM assessment is helpful for this purpose, and demonstrates that oil prices greater than $50 per barrel would result in very small amounts of additional oil production.

Opinions of economists about future oil prices are quite variable. In the 2005 Amended IAP/EIS, BLM developed different oil and gas activity scenarios based on the selected prices of oil. The highest price of oil considered was $30 per barrel, in line with then recent historic trends. Since then, the price of oil has increased to over $60 per barrel. While prudent companies base their investment decisions on conservative price assumptions regarding long-range oil and gas exploration and development decisions, we recognize that there has been a recent increase in the perception of long-range oil prices in recent years. In their 2007 annual energy outlook, the Department of Energy's Energy Information Agency projects the price of oil to be over $51 per barrel in 2010, dip to around $46 per barrel in 2020, and then rise to about $57 per barrel in 2030.

In this Supplemental IAP/EIS, BLM attempts to provide a realistic projection of the oil and gas exploration and development activities that could occur in the planning area. Although industry commonly bases its investment on conservative price projections, the current period of far higher long-term oil price projections suggests that scenarios resting on an assumption of development based on $30 per barrel run the risk of underestimation of development activities. But while the projections of long-term oil prices at substantially above $30 per barrel suggests that industry could profitably invest more in exploration and development than a $30 per barrel price would justify, assuming that all conventionally recoverable oil will be extracted is also unrealistic. Some conventionally recoverable oil may be located in small pockets that may never be discovered. Some oil may be conventionally recoverable but only at extremely high prices. Furthermore, given oil's central role in the world and national economies, increases in oil prices inevitably lead to higher prices for the equipment and supplies needed to extract oil and the workers required to design, maintain, and operate infrastructure. These increased costs would make it increasingly difficult for the oil industry to produce more oil. At very high oil prices the economically recoverable resource curve is nearly vertical and will only move toward the conventionally recoverable endowment at infinitely high (and therefore unrealistic) prices.

For this analysis, BLM is assuming that approximately 8 Bbbls of the 9.1 Bbbls risked mean conventionally recoverable oil in the Northeast and Northwest NPR-A could be economically recovered if there were no management constraints. Use of this number generates scenarios for analysis purposes that would represent reasonable projections for prices near or significantly greater than $50 per barrel. These scenarios, given the relative inelasticity of economically recoverable oil at high oil prices, remain adequate for impact analysis even if prices, or, more relevantly, industry's assessment of long-term prices used in their investment strategies, were assumed to rise as high as $100 per barrel.

Assuming the 8.0 Bbbl of economically recoverable oil is distributed evenly over the plays identified in the MMS and BLM assessment for the combined Northeast and Northwest planning areas, the Northeast NPR-A Planning Area would hold 54%, or about 4.3 Bbbl.

IV. Resource Potential and Petroleum-related Activities

A variety of activities are associated with petroleum development, beginning with tract leasing and concluding decades later with abandonment of depleted fields. For the purposes of environmental analysis in this Supplemental IAP/EIS, BLM has developed a set of hypothetical, but reasonable, development scenarios. The scenarios are based on an assumption that approximately 88% of the modeled petroleum resources (risked mean, technically recoverable oil estimate of 9.1 Bbbl) would be discovered and developed by industry. Typically, larger and more profitable fields are discovered early in the exploration cycle. Smaller and less profitable fields

may not be of interest to companies driven by profit motives. Companies may view the geologic or economic opportunities differently, and industry perceptions of economic potential may differ from those represented in our scenarios. Readers should be aware that actual development may differ significantly from BLM's hypothetical scenario. The general scope and nature of the activity is, however, based on the best and most current information available and is presented here as a reasonable, if likely high-end, representation of possible future activities. In order to develop a reasonable scenario and allow the reader to understand the rationale, BLM is required to make several assumptions.

A. Assumptions

There are many uncertainties associated with projecting future oil exploration and development. These uncertainties include the amount and location of technically recoverable oil; the timing of oil field discoveries and associated development; the future price of oil and, more to the point, the many oil companies' individual assessment of future prices and other competitive calculations that play into corporate investment decisions; and the geologic acumen showed by industry to find oil and their ability to mobilize the requisite technology to exploit it.

To address these uncertainties, the agency has made reasonable assumptions based on its knowledge of the largely undiscovered oil endowment of the planning area, on current industry practice, and on professional judgment. In making these assumptions, BLM has striven to minimize the chance that the resultant impact analysis will understate potential impacts. A couple assumptions are key. First, is the assumption that approximately 88% of the risked mean technically recoverable oil in the planning area would be developed if there were no management constraints. This amount of oil would be recoverable if industry determines to invest in North Slope oil production presuming that it could be sold for $50 or more per barrel. This is likely a higher price per barrel than industry currently uses and represents a position on the price-supply curve at which higher prices are unlikely to yield much additional production or resultant development. Second, the amount of infrastructure that would be necessary to develop that amount of oil is estimated conservatively. For example, it is assumed that each satellite production pad would require a 10-mile gravel road and pipeline of equal length, though the experience as ConocoPhillips develops the Alpine field would suggest that on average road and pipeline distances would not be so large.

Additional assumptions, some of which also tend to support an optimistic, though reasonable, set of development scenarios, include:

- Multiple lease sales would be held;
- Industry would aggressively lease and explore the tracts offered, which could require large numbers of exploration wells and seismic surveys;
- Several industry groups will independently explore and develop new fields in the NPR-A;
- For the purpose of developing a hypothetical scenario for impact analysis, a "Development Complex" generally will include one large CPF pad with 5 production pads. In fact there is likely to be a range of developments from a single CPF pad with no production pads, to CPF pads with 1-10 production pads, and the scenarios will reflect some variation. (See notes in Table 4.2-E.)
- This hypothetical Development Complex (Figure 4-1) comprises the following ranges of recoverable oil accumulations: one 250 - 450 MMbbl, one 60 – 70 MMbbl, two 50 - 60 MMbbl, and one 40 - 50 MMbbl and one 30 - 40 MMbbl. Using the mean accumulation values, a Development Complex will be capable of producing approximately 600 MMbbl

of recoverable oil (350 MMbbl produced from the main CPF pad and an average of approximately 50 MMbbl produced from each satellite production pad).

- Economic conditions (particularly oil price) would remain favorable to development in northern Alaska;
- New geologic information would not substantially change the present assessment of resource potential, future drilling would confirm what today are perceived as high-potential plays, and new high-potential plays would not be discovered;
- Projections of well numbers, facilities, and infrastructure include potential Alpine satellite developments in NPR-A; and
- Future petroleum production would use existing North Slope infrastructure, most importantly the TAPS pipeline.

Time frames for the development scenario are uncertain, because a future lease-sale schedule has not been established and the location and geologic characteristics and complexity of oil reserves and the future competitive opportunities for oil field investment worldwide are unknown. However, it is safe to assume that development activities associated with multiple future sales would continue for many years, as industry would require time to thoroughly evaluate existing leases before additional tracts would be leased. The complete inventory of petroleum resources in the NPR-A could take many decades. Note that two lease sales have occurred in Northeast NPR-A as a result of the ROD for the 1998 Northeast IAP/EIS. Twenty exploratory and delineation wells have been drilled on tracts leased in these two sales, with reports of discoveries of oil from five of those wells. However, more than eight years after publication of the 1998 Northeast IAP/EIS ROD, no construction to develop oil from these tracts has occurred and it is still not certain if the discoveries are commercially viable.

For the purposes of this analysis it is assumed that about ten years of exploration, proving, permitting, facility construction, and development drilling precede initial production. It is also assumed that development of multiple CPFs will not occur simultaneously, but instead occur approximately ten years apart. (Figure 4-4) This assumption takes into account the remote location of the planning area, the availability of equipment and personnel on the North Slope, regulatory requirements, and anticipated pipeline capacity. There is considerable economic benefit in bringing production online gradually to assure long-term maximum utilization of pipeline capacity. It is also assumed that development of each satellite would take about two years, allowing for a complement of satellites to be on-line before the next CPF is constructed to maximize sales pipeline throughput. It is possible, however, that several large finds are made and developed in a short period, or that no economic finds are made for a period extending beyond ten years, delaying the development of a new CPF.

Finally, the following analysis assumes that very little additional infrastructure would be required to develop commercial gas. Approximately 97.5% of the technically recoverable gas in the planning area is estimated to occur in plays with technically recoverable oil. Only minor portions of two gas-only plays occur in the Northeast NPR-A planning area. The larger of these two plays is estimated to hold 1.209 Tcf of gas, with .35 Tcf estimated to in the planning area. This is a geographically extensive play, encompassing nearly all of the planning area south of Teshekpuk Lake, so portions of it would be accessible from infrastructure projected under the scenarios in this Supplemental IAP/EIS to tap the oil resources. The other play is estimated to only hold .304 Tcf, and only 7%, or .02 Tcf of that is estimated to occur in the planning area. Because of the small volumes of gas in these gas-only plays, it is not considered likely under any foreseeable economic conditions that gas would be developed except as part of a development primarily undertaken to produce oil. Because the scenarios BLM has prepared for oil development are designed to minimize the chance that the amount of development, and thus

impacts, would be understated, BLM projects that the only significant additional infrastructure required by gas development in the planning area would be pipelines to transport gas from CPFs to gas pipelines east of the planning area and compressors at the CPFs and along the pipeline route.

B. Development Scenarios by Leasing Alternative

Several leasing alternatives are considered in this Supplemental IAP/EIS, each providing a different level of protection for resources and uses of the planning area. Alternative A is used as a basis for comparison and is unchanged from the Preferred Alternative contained in the 1998 Northeast IAP/EIS ROD for Northeastern NPR-A. Alternatives B and D under this analysis represent intermediate levels of surface resource and use protection between the 1998 Northeast IAP/EIS Preferred Alternative (Alternative A) and Alternative C in this EIS, which would open the entire planning area to leasing and development. The projected infrastructure needs if all 4,300 MMbbls of oil considered possible to develop if no management constraints were placed on development in the planning area are presented in Tables 4.2-D and 4.2-E for comparison purposes.

New commercial oil fields are most likely to be discovered in the northern portion of the planning area that has been designated as having high potential for the occurrence of petroleum resources. This area encompasses approximately the northern one-third of the planning area (Figure 4-5). It is impossible to predict, however, what proportion of exploration and development could occur in the medium to low occurrence potential areas. Prospective offshore areas under NPR-A jurisdictions could be reached using directional drilling techniques from onshore pads or from offshore artificial islands.

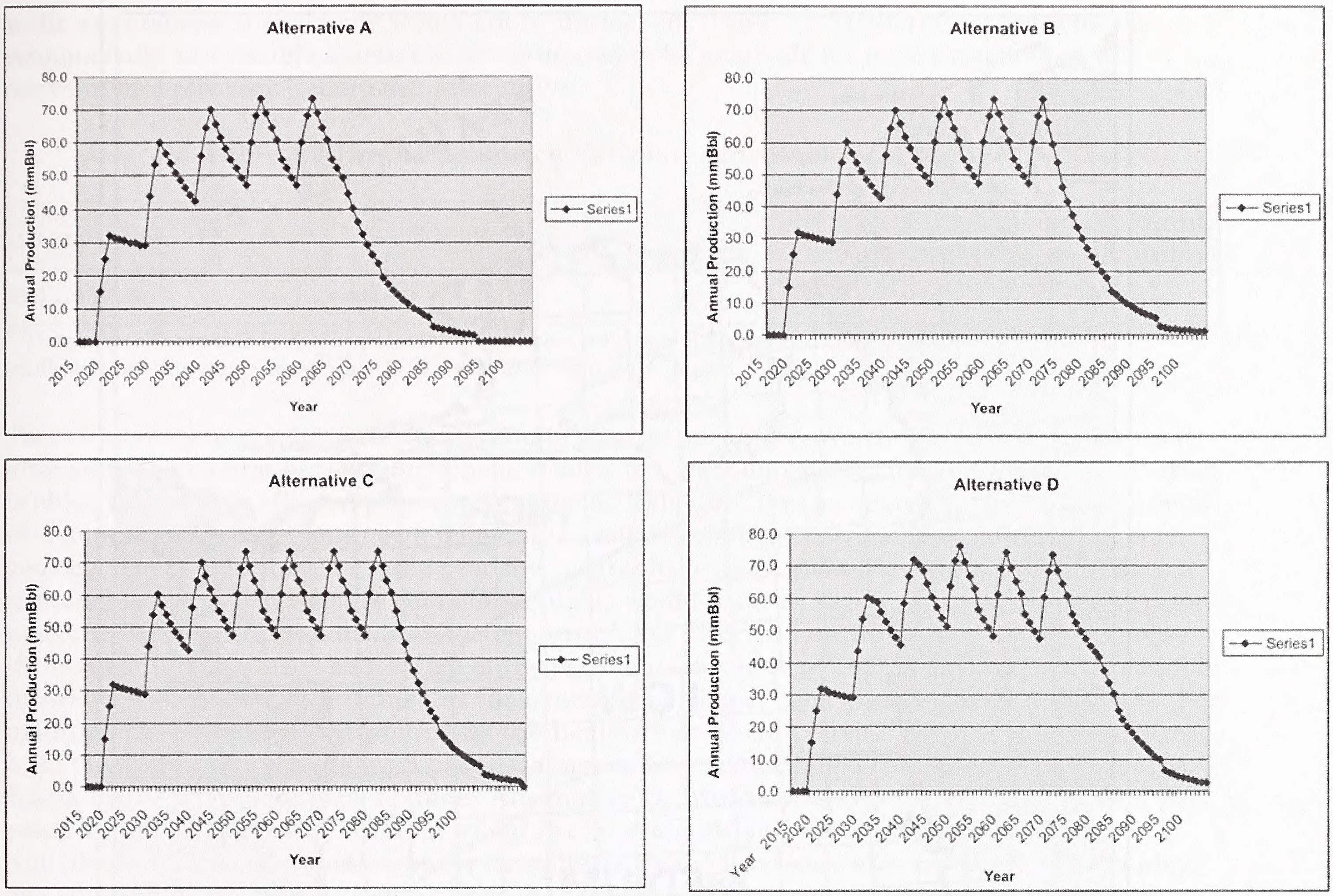

Figure 4-4. Assumed annual production rate by Alternative

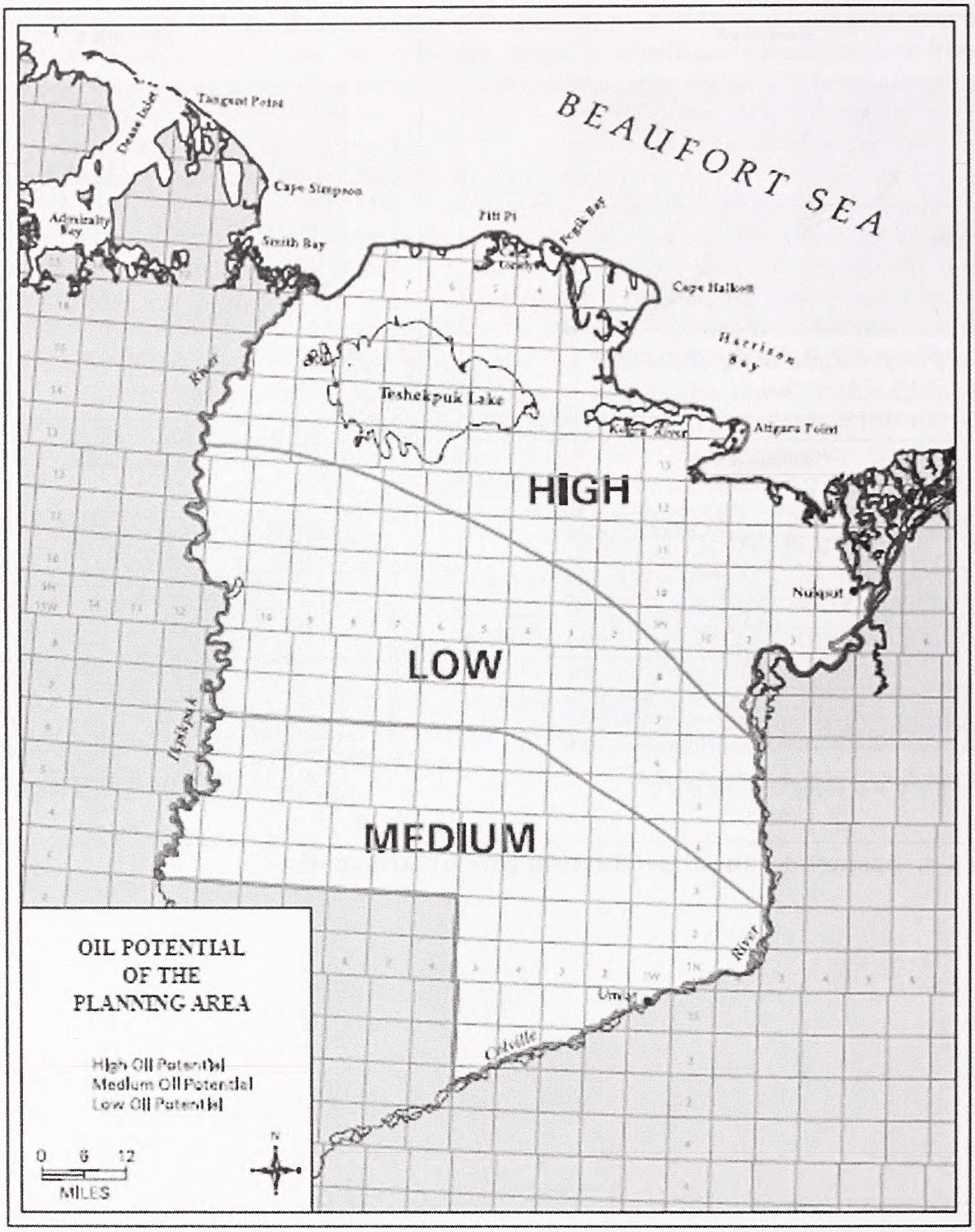

Figure 4-5. Oil Occurrence Potential Map of the Planning Area

C. Projected Activity Levels for Each Leasing Alternative

The scenarios used in this Supplemental IAP/EIS assume that approximately 4,300 MMbbl of oil could be produced in the planning area if there were no management constraints. The resource estimates are reduced for the alternatives because there is an unavoidable trade-off between the level of protection and the feasibility of future petroleum operations. A precise evaluation of the impacts of regulatory restrictions is not possible because the magnitude of these effects would vary depending on the location of as-yet undiscovered oil fields. If a prospect were located in an area unavailable for leasing or in an area too far from lands on which oil

wells are allowed, it obviously would not be developed. Table 4.2-D, therefore, presents the economically recoverable amount of oil estimated to be available for production using conventional recovery under each alternative.

Table 4.2-D. Oil Resource Estimates for Each Alternative*

Alternative	A	B	C	D	Without Mgmt. Constraints
Oil (MMbbl)	2,900	3,350	4,050	3,700	4,300

* These figures provide realistic estimates for impact analysis purposes that make it very unlikely that this Supplemental IAP/EIS will underestimate impacts.

Two reductions in the 4,300 MMbbl estimate of economically recoverable oil are made for each alternative. The first set of reductions is related to areas unavailable for leasing. This reduction is objective because affected play areas are measurable from maps. Because the exact locations of commercial fields are unknown today, it is assumed that the petroleum endowment in each geologic play is distributed evenly over the geographic extent of the play. Admittedly, this is a simplistic assumption because commercial fields would occur in localized pools. However, prior to extensive mapping and drilling, the opportunity to discover new fields is relatively uniform throughout a play area. The fraction of the petroleum resource available for leasing and possible future development is determined as the available portion of each play in the planning area. For instance, the estimated oil resource for the Beaufortian Barrow Arch Play in the planning area is 2,700 MMbbl. By scaling from play area maps, it was determined that 10% of the play area would not be offered for leasing under Alternative D. Multiplying this fraction by the total play resource indicates that 270 MMbbl would not be available and consequently would not contribute to future production under this alternative. The recoverable resources in each play are adjusted by geographic scaling from the total play endowments to determine the available portions within the planning area, and then all play resources are summed to an area-wide total.

A second set of reductions is also objective, as it is based on areas affected by restricted surface occupancy (RSO) restrictions in setbacks (or buffers) that provide protection for sensitive localities. RSO restrictions, which prohibit oil and gas facilities other than pipelines, could reduce industry interest in leasing, add costs to operations, or present difficult engineering challenges. Reductions for production estimates are valid even if the area underneath the buffer and enclosed area is technically reachable by directional drilling. In most cases, surface restrictions that would require directional drilling beyond 1 mile would cause economic burdens that could result in bypassed resource recovery or the elimination of marginal projects. (USDOI, USDA, and DOE, 2006). Consequently, projections of oil recovery reflect a reduction equal to the estimated oil in lands with a RSO restriction more than one mile from areas without RSO restrictions.

Table 4.2-E. Estimated Petroleum-related Activities for Each Alternative*

Alternative	A	B	C	D	Without Mgmt.
Exploration Wells[2]	86	97	120	110	128
Delineation Wells	65	73	90	83	96
Exploration/Delineation Drilling Rigs[3]	5	6	8	7	8
CPFs[4]	5	6	7	6	7
Satellite Production Pads[4]	23	25	32	32	38
Production and Service Wells[5]	971	1,082	1,353	1,306	1,545
Production Drilling Rigs[6]	2	2	2	2	2
Staging Bases	2	3	4	3	5
Peak Oil Production[7]	74	74	74	76	76

* These figures provide realistic and conservative estimates for impact analysis purposes that make it very unlikely that this Supplemental IAP/EIS will underestimate impacts.

[1] The scenario for development without management constraints is not analyzed here and is shown for comparison purposes only;

[2] Based on # of wildcat wells required to produce all economically recoverable oil in central coastal and central foothills subareas of North Slope (180 wells @ $30/bbl + 60 wells @ $30/bbl) from Attanasi and Bird 1995). Planning Area is 60% (aerial extent) of the central coastal subarea and 15% of central foothills subarea (0.6 x 180 = 108 wells; 0.15 x 60 = 9 wells). Adjust these values by 15% to reflect the change in conventionally recoverable oil volume from 7.0 Bbbl @ $35/bbl to 8.0 Bbbl @ near or greater than $50/bbl for Northeast and Northwest planning areas combined: Northeast planning area play volume = 54 % of 8.0 Bbbl conventionally recoverable oil volume (54% of 15% = 8%; (108 wells x 1.8) = 118 wells + 9 wells x 1.8 = 10 wells; 118 + 10 = 128 exploration wells). Exploration well totals include commercial discoveries and dry holes. See Table 4-6 for explanation of Alternative calculation.;

[3] Rig totals are the maximum number operating in any single year.;

[4] For this analysis, a Development Complex contains a hypothetical 600 MMbbl of economically recoverable oil that comprises the following: one 350 MMbbl accumulation and five 50 MMbbl accumulations. Consequently, for every 600 MMbbls estimated, one CPF and 5 satellites are projected. If estimated oil or a portion of the total estimated oil not accounted for by a full 600-MMbbl Development Complex is

1.) less than 25 MMbbls, i.e., less than half of the estimated production of a satellite pad, no development would occur; 2.) more than 25 MMbbls but less than 200 MMbbls, no CPF is projected, but instead this oil is projected to be produced from additional satellites (e.g., the estimated Alternative D oil total of 3,700 MMbbl would drive development of 6 CPFs with an average of 5 satellite pads each [6 Development Complexes x 600 MMbbls = 3,600 MMbbls] and 2 additional satellites [2 satellite pads x 50 MMbbls approximately = 100 MMbbls] which could be connected either to one of the projected CPFs or to the Alpine CPF outside the planning area, ; 3.) between 200 MMbbls and 350 MMbbls, an additional CPF is projected, but no additional satellites, or 4.) greater than 350 MMbbls and less than 600 MMbbls, an additional CPF is projected and one satellite pad for every 50 MMbbls in excess of 350 MMbbls (e.g., the estimated oil volume for Alternative A of 2,900 MMbbls would drive development of 4 CPFs with an average of 5 satellite pads each [4 Development Complexes x 600 MMbbls = 2,400 MMbbls] with a remaining 500 MMbbls driving an additional CPF and 3 more satellite pads. Total = 5 CPFs and 23 satellite pads.)

[5] Production to service well ratio is 2:1 (Attanasi, 2003); (note that the Alpine oil field ratio is 1:1).

[6] Number of drilling rigs per year for: Alternative A (48 years), Alternative B (52 years), Alternative C (66 years), Alternative D (62 years)

[7] Assume CPF peak production = 100,000 BOPD and Satellite peak production = 15,000 BOPD. Peak oil production in MMbbl per year.

Constraints other than RSO restrictions contained in the stipulations and ROPs as well as permitting requirements that would be imposed on oil development by other Federal agencies as well as state and local governments also could reduce the amount of oil that would be recovered from the planning area. BLM has assessed that the technical impediments and economic costs of these less-than-RSO restrictions presented in this Supplemental IAP/EIS would be roughly the same for each alternative. At lower oil prices these impediments and costs may dissuade industry from pursuing some oil prospects or cause industry to develop the prospects more cautiously and slowly than at higher prices. For this impact analysis, however, we are assuming that prices for oil will be high enough that approximately 88% of the conventionally recoverable oil would be developed. Under these circumstances the economic return industry would receive on oil development would justify overcoming the technical impediments and economic costs inherent in Federal, state, and local government regulations other than those imposed by large RSO areas and areas not available for leasing.

The petroleum resource assessment indicates that a few plays could hold a large majority of the total resource endowment. Restrictions affecting these "rich plays" would have a disproportionate affect on the future development potential of the area. For example, the Beaufortian-Barrow Arch play (with analogs to the Alpine oil field) could contain approximately 60% of the economic oil resources. The geographic extent of this play overlaps many of the biologically and culturally sensitive areas in the northern portion of the planning area, though it by and large lies south of Teshekpuk Lake. Restrictions affecting this play could have a large impact on future oil and gas production from the NPR-A.

Using these general concepts and reduction factors, resource estimates are defined for each of the alternatives. The specific reduction factors are identified by abbreviations: areas unavailable for leasing (UL) and restricted surface occupancy buffers (RSO).

No Action Alternative (Alternative A). The No Action Alternative would continue to withhold approximately 600,000 acres from leasing and development (Map 2-1). Approximately 87% of the planning area would be available for leasing. Specific reductions for this alternative are estimated at UL (25%) and RSO (10%). Under this alternative, oil production is estimated at 2,900 MMbbl (Table 4.2-D).

Alternative B. Under Alternative B, over 95% of the area would be offered for leasing, but 213,000 acres in the northern (high potential) part of the planning area would not be available for leasing (Map 2-2). The specific reductions are UL (17%) and RSO (7%). Under this alternative, oil production is estimated at 3,350 MMbbl (Table 4.2-D).

Alternative C. Under Alternative C, the entire planning area would be available to leasing (Map 2-3). The specific reductions are listed as UL (0%), RSO (7%). Under this alternative, oil production is estimated at 4,050 MMbbl (Table 4.2-D).

Alternative D. Under Alternative D, over 95% of the area would be offered for leasing; the 211,000-acre Teshekpuk Lake would be deferred from oil and gas leasing (Map 2-4). In addition, permanent oil and gas facilities (except pipelines and publicly-funded community roads) would not be allowed on approximately 347,400 acres and no permanent oil and gas facilities, pipelines, or publicly-funded community roads would be allowed on 16,950 acres. The specific reductions are UL (8%) and RSO (7%). Under this alternative, oil production is estimated at 3,700 MMbbl (Table 4.2-D).

D. Projected Seismic Activity by Leasing Alternative

Individual 2-D survey lines would be several miles apart and the surveys would likely be used to tie between existing wells or as infill to existing surveys. The 2-D surveys would occasionally be used to connect areas of 3-D coverage. About 10 vehicles, including Vibroseis (sound source) vehicles and receiving vehicles (geophone support and recording equipment), would run each line of 2-D seismic. Approximately 40 to 60 personnel would be required for each survey group including all support personnel associated with the winter camp. The vehicles would run parallel to each other through an area about 200 feet wide and the survey party would collect 5 to 10 line-miles of seismic data per day. The camp train would travel an equal distance per day. The maximum area covered by seismic vehicles would be approximately 6,060 acres (250 miles x 200 feet wide), although not all of the area within the 200-foot-wide path would be traversed by vehicles.

A typical 3-D seismic operation can survey an area of about 600 mi^2 in a single winter season. An operation like this typically would involve about 15 vehicles. Each line-mile would consist of a pair of linear areas, each about 100-feet wide, through which the vehicles would drive. The grid patterns for 3-D seismic surveys would be considerably closer spaced than those of 2-D surveys. The receiver lines would be spaced 1,100 feet apart, while the source line upon which the survey units and vibrator travel would be spaced 1,320 feet apart and cross diagonally to the receiver lines. Vehicle travel would be restricted within the grid area. In general, all vehicles would travel within 50 feet of receiver lines. For any given receiver line, a path of about 100 feet could be impacted by vehicle use (50 feet on either side of the line). The area impacted along the source line would be less than 50 feet wide. For each square mile surveyed, 24.2 acres would be impacted along the source lines, and 58.2 acres would be impacted along the receiver lines, or 82.4 acres total per square mile surveyed (13% of the survey area). This estimate is considered high, since some areas impacted would be common to both the source and receiver lines.

The techniques of setting up geophone arrays and shot points are similar for 2-D and 3-D surveys. However, 3-D surveys are more efficient because the equipment does not have to move far between lines, and 3-D surveys generally provide better coverage of subsurface features. The exterior dimensions of 3-D survey blocks could range to tens of miles on a side. The number of line-miles crossed in a 3-D survey area would be much greater than for 2-D surveys because the survey lines would be closer together. Impacts to soil and vegetation from 3-D surveys are usually less than for 2-D surveys as rubber-tracked vehicles are used and camp moves generally move down the center of the survey line. They are more expensive than 2-D surveys, and are not used for initial reconnaissance mapping unless it is essential to map subtle stratigraphic prospects.

Almost the entire planning area has been covered by 2-D surveys. The U.S. Navy, and later the USGS/Husky, conducted an extensive exploration program during the 1970s to early 1980s. Figure 4-6 shows areas surveyed by the USGS during this period. Additional 2-D surveys have been conducted since the late 1970s in the planning area, but information from these surveys is proprietary and therefore not included in Figure 4-6. Almost the entire area of high oil and gas occurrence potential in the planning area has been covered by 3-D seismic surveys. These 3-D surveys have been instrumental in identifying stratigraphic prospects in the planning area similar to the Alpine, Tarn, and Meltwater fields. Since 1998, about a dozen 3-D seismic surveys have covered approximately 2 million acres (3,200 mi^2), or 44% of the planning area. A basic assumption for this analysis is that seismic surveys would not be repeated in areas for which survey data are already available. It would be much less expensive to purchase data from the

original contractor (or client) rather than conduct a new survey. Therefore, it is assumed that future seismic surveys with today's technology would be conducted only in unsurveyed areas and would total three 2-D surveys and two 3-D surveys. If in the future new technology makes resurvey attractive, additional seismic surveys may occur. The amount and type of such surveys will depend upon the then-current state of technology and geologic knowledge relevant to potential prospects in the planning area.

The foothills located south of the existing 3-D seismic coverage might require additional seismic surveys. Current 2-D seismic data on a reconnaissance grid has been used to identify numerous structural (anticlinal) features. Although 2-D seismic data is less expensive to acquire than 3-D seismic data, and can adequately image subsurface structure enough to proceed with exploration drilling, it is likely that local 3-D seismic surveys in the foothills, south of existing 3-D surveys (see Figure 4-6), will be collected for field delineation.

The following discussion recognizes the tradeoff of 3-D (better resolution at higher cost) versus 2-D seismic surveys. General assumptions on the type and location of probable activities are used for the purpose of impact analysis. As seismic survey techniques improve, more seismic data may be gathered in less time than is described here.

At this time, the Teshekpuk Lake area, which is currently largely excluded from leasing, is recognized as an area of high oil and gas potential. Existing seismic survey lines over the lake area are relatively sparse, so it is assumed that additional seismic survey work would be necessary prior to exploration drilling if substantial parts of the lake were made available for leasing. Winter over-ice surveys were conducted on Teshekpuk Lake in 1974 and 1975 using dynamite as a sound source. Approximately 120 miles of 2-D seismic data were collected. Although Teshekpuk Lake is a high priority area for 3-D seismic data acquisition, there may be attendant logistical problems for more preferable Vibroseis surveys in this area. Furthermore, the use of explosives to collect seismic survey information may not be appropriate if there are substantial impacts to fish and wildlife. A lake survey could be done during the summer using boats and airguns, as is done offshore.

Under all of the alternatives, it is projected that three 2-D and two 3-D surveys would be done to fill in gaps in existing surveys. Under Alternatives A and D it is unlikely that seismic surveys would occur on Teshekpuk Lake. Two-D surveys are most likely in the foothills area. The length of 2-D surveys would be much shorter than normal, however, and the total length for all surveys would be approximately 250 miles. These surveys could be accomplished in as little as a season or two. The maximum area impacted by 250 miles of seismic lines would be 6,060 acres (250 miles by 200 feet wide). This figure is presented as a maximum, because not all of the area within a 200-foot-wide line actually would be overrun by a vehicle. Trails also are made by camp-move vehicles, which traverse about the same distance as line miles of 2-D survey as well as traveling to and from the survey area. For analysis purposes, it is estimated that a round trip into the planning area to the site of seismic surveying and return would be 106 miles. A camp-move trail is about 12 feet wide, and it is assume the camp train would involve two to three strings of trailers. These strings could use the same trail, but this would cause greater damage than to use separate trails. For this analysis, it is assumed that on average, 2.5 camp-train strings would use different trails to decrease overall damage and, therefore, camp-move trails effectively would impact a path 30 feet wide. Assuming that there would be three 2-D surveys that on average would require a roundtrip camp move of 106 miles, camp moves to and from seismic survey areas would potentially impact 1,156 acres. This would be in addition to 910 acres potentially disturbed by camp train moves along the total 250 miles of anticipated 2-D seismic.

Three-D seismic surveying would, as noted above, potentially impact 82.4 acres per square mile. Thus, two 5,280-mile 3-D surveys would potentially impact 98,880 acres. In addition, it is assumed that camp trains would move approximately 30 miles within the surveyed areas and 106 roundtrip to reach the area, thus potentially impacting 990 acres.

Table 4.2-F. Mileage and Acreage of Seismic Surveying for All Alternatives

	Surveying miles	Surveying acres	Camp Train miles	Camp Train acres
2-D	250	6,060	568	2066
3-D	10,560	98,880	272	990

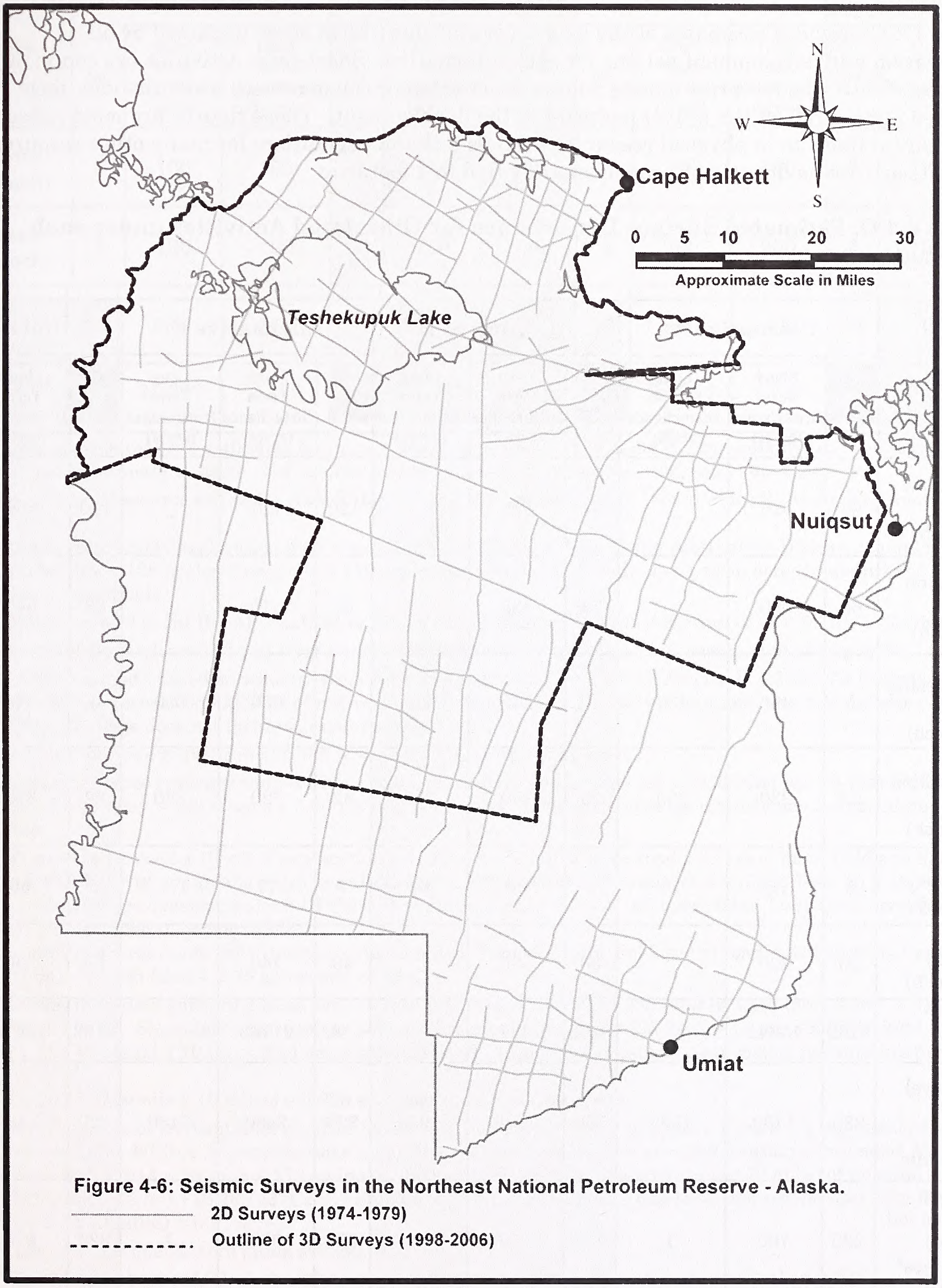

Figure 4-6. Seismic Surveys Conducted in the Northeast National Petroleum Reserve – Alaska.

V. Estimated Surface Disturbance Due to Petroleum-related Activity

Table 4.2-G provides estimates of the long-term and short-term acres impacted by oil exploration and development actions for each alternative. Short-term activities are commonly associated with the footprint during winter exploration or construction, while the long-term acreage figures reflect the gravel footprint of the development. These figures are most reflective of potential impacts to physical resources such as soil and vegetation; for many other resources, impacts are not as directly or proportionately tied to a footprint.

Table 4.2-G. Estimated Surface Disturbance for Oil-related Activities under each Alternative*

Type of Action	Alternative A			Alternative B			Alternative C			Alternative D		
	No.	Short Term Disturbance (acres)	Long Term Disturbance (acres)	No.	Short Term Disturbance (acres)	Long Term Disturbance (acres)	No.	Short Term Disturbance (acres)	Long Term Disturbance (acres)	No.	Short Term Disturbance (acres)	Long Term Disturbance (acres)
Oil Exploration Wells[1] (6 acres each)	86	516	_	97	582	_	120	720	_	110	660	_
Oil Delineation Wells[2] (6 acres each)	65	390	_	73	438	_	90	540	_	83	540	_
Central Processing Facility[3] (90 acres each)	5	450	450	6	540	540	7	630	630	6	540	540
Gravel Production Pads[3] (10 acres each)	23	230	230	25	250	250	32	320	320	32	320	320
Gravel Runway[4] (11 acres each)	5	55	55	6	66	66	7	77	77	6	66	66
Ice Runway[5] (11 acres each)	20	220	_	30	330	_	40	440	_	30	330	_
Ice Roads[6] (miles)	5162	15642	_	6162	18672	_	7182	21763	_	6162	18672	_
In-field Gravel Roads[7] (miles) 7.75 acres/mile	230	1783	1783	250	1938	1938	320	2480	2480	320	2,480	2,480
Three-phase Produced Fluids (oil, gas, water) Gathering Lines[8] (miles)	230	700	1	250	760	1	320	972	1	320	972	1
Sales Oil Pipelines[9] (miles)	162	491	1	162	491	1	182	551	1	162	491	1

Type of Action	Alternative A			Alternative B			Alternative C			Alternative D		
	No.	Short Term Disturbance (acres)	Long Term Disturbance (acres)	No.	Short Term Disturbance (acres)	Long Term Disturbance (acres)	No.	Short Term Disturbance (acres)	Long Term Disturbance (acres)	No.	Short Term Disturbance (acres)	Long Term Disturbance (acres)
Pump Stations[10] (20 acres each)	5	100	100	6	120	120	7	140	140	6	120	120
Staging bases[11] (50 acres each)	2	100	100	3	150	150	4	200	200	3	150	150
Gravel pits (50 acres each)[12]	11	550	550	13	650	650	16	800	800	14	700	700
Total Acres of Disturbance		21,227	3,270		24,987	3,716		29,634	4,649		26,000	4,378

* These figures provide realistic estimates for impact analysis purposes that make it very unlikely that this Supplemental IAP/EIS will underestimate impacts. For seismic survey potential disturbance area, see Table 4.2-F.

[1] Ratio between the oil resource estimates from Table 4-4 and the conventionally recoverable oil resource estimate (4,300 MMbbl) x conventionally recoverable exploration well count (128 wells; Table 4.2-E). Using Alternative D as an example: 3,700 MMbbl/4,300 MMbbl x 128 exploration wells = 110 exploration wells (high end). Long-term acreage disturbance not calculated but assumed to be negligible

[2] Assume delineation well count (by Alternative) is 75% of exploration well count. Alternative D = (0.75 x 110 exploration wells) = 83 delineation wells (high end). Long-term acreage disturbance not calculated but assumed to be negligible

[3] Number of CPFs estimate based on volumes from Resource Estimates by Alternative (Table 4.2-D). As assumed in this analysis, one CPF represents 350 MMbbl of recoverable oil. See Table 4.2-E for assumptions and calculations regarding the number of CPFs. Acreage does not include gravel runway.

[4] Assume each CPF has one gravel runway 100 ft wide x 5,000 ft long = 11 acres.

[5] Assume the number of ice runways ranges from 1 to 4 (Alternative dependent) per year during the 10-year exploration phase (Table 4.2-B). Ice runway = 100 ft wide x 5,000 ft long = 11 acres. Long-term acreage disturbance not calculated but assumed to be negligible

[6] Assume: (50 miles of ice road x 10 yrs of exploration x #CPFs) + (50 miles of ice road x 10 yrs of main field and satellite development x #CPFs) + (# of pipeline miles per alternative). For example: Alternative A = (50 miles x 10 yrs exploration x 5 CPFs) + (50 miles x 10 yrs development x 5 CPFs) + (162 miles of pipeline) = 5,162 miles total. Long-term acreage disturbance not calculated but assumed to be negligible.

[7] Assume 10 miles of gravel roads per satellite production pad. Typical Alpine field gravel road = 64 feet wide (measured from the base) x 1 mile x 5,280 ft/mi = 7.75 acres/mile of road.

[8] Assume 10 miles of in-field gathering lines per satellite production pad. VSM diameter of 12 in (area = πr^2 = 3.14 x 36 sq in = 113 sq in = 0.785 sq ft). Short-term disturbance per satellite production pad = (25 ft-wide ice road x 5,280 ft/mi x 10 mi) + (0.785 sq ft x 150 VSMs/mi x 10 mi) = 30.4 acres/satellite production pad. Long-term disturbance per satellite production pad = (0.785 sq ft x 150 VSMs/mile x 10 miles) = 0.028 acres/satellite production pad.

[9] Assume 72 to 182 miles of transmission pipeline based solely on geologic play potential, Figure 4-2 represents speculative pipeline corridors in the NPR-A. No implications regarding specific hydrocarbon prospect location is intended. VSM diameter of 12 in (area = πr^2 = 3.14 x 36 sq in = 113 sq in = 0.785 sq ft). Short-term disturbance per 72 miles of pipeline = (25 ft-wide ice road x 5,280 ft/mi x 72 mi) + (0.785 sq ft x 81VSMs/mi x 72 mi) = 218 acres. Long-term disturbance per 72 miles = (0.785 sq ft x 81 VSMs/mile x 72 miles) = 0.11 acres.

[10] Assume each CPF has one 20-acre pump station.

[11] Assume 1 to 4 staging bases of 50 acres each to be used during 10 year exploratory phase (Table 4.2-B).

[12] A 50-acre borrow pit 20 feet deep = 1.6 million cu. yds. Alternative A requires 18 million cu. yds. of gravel (10,000 cu. yds. x 90 acres x 5 CPFs = 4.5 million cu yds.; 10,000 cu. yds. x 10 acres x 23 pads = 2.3 million cu yds.; 10,000 cu. yds. x 11 acres x 5 airstrips = 0.55 million cu yds.; 10,000 cu. yds. x 50 acres x 2 staging area = 1million cu yds.; 41,000 cu. yds. x 10 acres x 28 in-field roads = 9.4 million cu yds.); 18 million cu. yds/1.6 million cu. yds. = 11 gravel pits.

4.2.2 Oil Spills

This section summarizes the probability, behavior, and potential impacts that might result from a variety of oil spill scenarios. The spill scenarios used in this amendment, especially for larger volume spills, are likely to overestimate, in some cases substantially, the probability of a spill and/or the potential impacts. The probability of and impacts from oil spills on the North Slope have received extensive analysis and review in several recent EISs, EAs, and other reports. Though the details differ among several of the documents, the basic data and conclusions are generally similar. We incorporate these documents by reference and summarize the key points in this amendment. Referenced documents include the following:

- Northeast National Petroleum Reserve – Alaska Final Amended IAP/EIS (USDOI BLM 2005)
- Northwest National Petroleum Reserve – Alaska Final IAP/EIS (USDOI BLM and MMS 2003)
- Northeast National Petroleum Reserve – Alaska Final IAP/EIS (USDOI BLM and MMS 1998)
- Alpine Satellite Development Plan EIS (USDOI BLM 2004c)
- Liberty Development and Production Plan Final EIS (USDOI MMS 2002a)
- Beaufort Sea Oil and Gas Development/Northstar Project Final EIS (USACE 1999)
- Renewal of the Federal Grant for the Trans-Alaska Pipeline System Right-of-Way Final EIS (USDOI BLM 2002)
- Environmental Report for the Trans-Alaska Pipeline System Right-of-Way Renewal (TAPSO 2001)
- Cumulative Environmental Effects of Oil and Gas Activities on Alaska's North Slope (NRC 2003)
- A Review of Oil Spill Risk Estimates Based on Current Offshore Development Technologies (NSB 2003a)
- Situation Report #22, GC-2 Oil Transit Line Release, (Alaska Department of Environmental Conservation, 2006)

In the NPR-A Planning Area, spills occur from pipelines, storage tanks, production and exploration pads, drilling rigs (well blowouts), airstrips, roads, vessels and bridges. Spills that leave the pads and roadbeds, or enter water sources directly, could reach one or more of several habitat types, including wet and dry tundra, tundra ponds, lakes, flowing creeks and rivers, and potentially the adjacent nearshore Beaufort Sea. Spills could occur anytime during the year.

In addition to hydrocarbon spills, spills of other types of materials are reported and tracked as well. For instance, seawater spills can be quite large and have the potential to effect large areas. Seawater spills to fresh water can have significant impact. Other types of spills that are reported and tracked include spills of sewage and hazardous materials. This analysis focuses on the probability and potential impacts of hydrocarbon spills.

4.2.2.1 History of North Slope Oil Spills

The 30-year North Slope history shows that the vast majority of the oil, produced fluids, seawater, and other material spills that have occurred have been very small (less than 10 gallons; ¼ bbl) and very few have been greater than 100,000 gallons, including a 2,380 bbl spill in 2003 (NRC 2003) and a 4800 bbl spill in 2006 (ADEC 2006). The probability of a very large spill greater than one million gallons is extremely low (USDOI BLM and MMS 1998).

An NRC (2003) report entitled *Cumulative Environmental Effects of Oil and Gas Activities on Alaska's North Slope* summarized the history of North Slope oil spills at that time: "Major oil spills have not occurred on the North Slope or adjacent areas as a result of operations [of the oil fields]... Many small terrestrial spills have occurred in the oil fields, but they have not been frequent or large enough for their effects to have accumulated. They have contaminated gravel, which has been difficult to clean up and has made the gravel unavailable for rehabilitation." Appendices F and G of the same NRC report provide the most recent detailed analysis of risk, size, type, and general impacts of North Slope oil spills. These analyses are the basis for the above-quoted conclusion. More recently, in 2006, a large spill occurred from a 34 inch diameter crude oil transit pipeline known as the GC-2 spill. It was estimated at 201,000 gallons +/- 33%, or 4,800 bbls. The spill volume was large because it was a small leak from a low pressure line that went undetected for some time. Yet the same conditions that allowed it to continue undetected (snow cover and low temperatures) limited the spread of oil and environmental impact to approximately two acres. The estimated spill sizes computed in this report for large spills take the GC-2 spill into account and increase the projections notably.

Most Alaskan North Slope spills have been contained on gravel pads and roadbeds (NRC 2003), and most of those that have reached the tundra have covered fewer than five acres (USDOI BLM and MMS 1998). Also, as noted above, snow cover and low temperatures through much of the year also reduces risk of extensive spread of leaked oil. Upon detection, spills have been promptly contained and cleaned up as required by state, Federal, and NSB regulations (NRC 2003).

When a spill occurs, significant analysis takes place on the causal factors that contributed to the event. Lessons learned from the GC-2 spill have contributed to The Pipeline Inspection, Protection, Enforcement and Safety Act of 2006, signed by President Bush on December 29, 2006. The Act extends the oversight jurisdiction of the USDOT to oil and gas pipelines operating at low pressure, like the GC-2 transit pipeline.

4.2.2.2 Northeast NPR-A Oil Spill Analysis

The information, models, and assumptions used to analyze the potential for oil spills are described in Appendix K. Predicting an oil spill is an exercise in probability, based on historic data. There is uncertainty in the location, number, and size of any spills, the chemistry of spilled oil, and the environmental conditions at the time of a spill. This analysis considers the entire life of the planning area and much of the information in this section is reflected in the 1998 Northeast IAP/EIS (USDOI BLM and MMS 1998) and the Northeast National Petroleum Reserve – Alaska Final Amended IAP/EIS (USDOI BLM 2005). Recent oil spill history has been incorporated into this updated analysis.

The oil-spill analyses in this amendment are based on three spill-size categories: 1) small spills (< 500 bbl); 2) large spills (≥500 to < 120,000 bbl); and 3) very large spills (≥120,000 bbl). Over the lifetime of exploration and development of the planning area, the probability of small spills occurring is high, and small spills are expected to occur. The numbers project that several large spills will also occur. The probability of a very large spill occurring is very low.

The responses to a spill and amount of oil removed are variable and dependent upon the weather conditions, time of year, location, the size of the spill, and other factors. The amount of oil removed can range from none to effectively all of the oil. By assuming no cleanup, the

estimated effects to the resources would tend to be overestimated, or greater than what would actually occur.

Large Oil Spills

Of concern to stakeholders are the potential effects of oil spills on the environment. This section summarizes the key variables used for oil-spill analysis. For further details on any of these points, please refer to Appendix K.

Information on large oil spills is based on historical data from the North Slope. This introduction summarizes the assumptions used to analyze large oil spills, which are a mixture of project-specific information, modeling results, statistical analysis, and professional judgment. Spills from the Trans-Alaska Pipeline System (TAPS) are included in the analysis, including the spill that occurred in 2001 when a bullet punctured the 48-inch TAPS mainline, notwithstanding that the spill did not occur on the North Slope. Approximately 6,800 bbl of crude oil were released from this intentional sabotage.

Assuming the amount of oil produced provided in **section 4.2.1.2**, and based on historic spill events, 2 to 3 large spills may occur during the life of oil development that might proceed from leasing in the Northeast NPR-A. Specifically, the estimated number of large spills occurring under alternatives A, B, C, and D is 2.475, 2.775, 3.45 and 3.15, respectively.

Table 4.2-H. Assumed Large (≥ 500 barrels) Crude Oil Spills for Life of the Northeast National Petroleum Reserve – Alaska

Alternative	Estimated Number of Large Spills	Estimated Total Large Spill Volume (bbl)
Crude Oil		
A	2.175	10,440
B	2.513	12,062
C	3.038	14,582
D	2.775	13,320
The estimated number of oil spills is based on the estimated volume of resources multiplied by the historic Alaska North Slope spill rate. See Appendix K for a detailed explanation.		

Large spill scenarios use the volume based on the largest spill to have historically occurred on the North Slope for that type of facility, e.g., a 4,800-bbl crude spill from a pipeline event or a 900-bbl crude or diesel oil spill from a gravel pad facility. For analysis purposes, it is assumed that two pipeline spills will occur under Alternative A and that three such spills could occur under the other alternatives. A large spill from a planning area facility or pipeline could happen at any time during the year. Scenarios were created in which a spill could reach any of the following environments:

- Gravel pad and then the tundra, snow, or ice (gravel pad not assumed to retain any oil);
- Open water (lagoon, lake, or river);
- Broken ice (lagoon, lake, or river);
- On top of or under solid ice (lagoon, lake, or river);
- Shoreline (lagoon, lake, or river); or
- Tundra or snow and ice.

Based on modeling, the large spill scenario (4,800 bbl) assumes that after 30 days in open water or broken ice, 23-40% of the oil evaporates, 0-22% disperses, and 38-77% of the oil remains. After 30 days under ice in a lagoon or lake, nearly 100% of the oil remains in place and unweathered.

The analysis of the effects of large oil spills is based on the following assumptions:

- The spill size is 4,800 bbls. per spill;
- All the oil reaches the environment and the gravel pad absorbs no oil;
- The spill starts at the gravel pad or along a pipeline or from a well blowout or tank rupture;
- There is no cleanup or containment;
- The oil chemistry is similar to that of Alpine field oil;
- The spill could occur at any time of the year;
- A spill under a lagoon or lake ice from planning area facilities or pipelines does not move substantially until the ice breaks up; and
- Spill locations and dates used in the analyses are those that would result in the greatest impact.

Small Oil Spills

The consequences of small spills of crude and refined oil are analyzed to address concerns about the chronic effects from numerous small spills. The small spills assumed for this analysis are shown in Table 4.2-I. For this analysis, it is assumed that:

- Small crude spills can begin anywhere on the gravel pad facilities or along the pipeline;
- Small spills on gravel pads occur in contained areas or are cleaned up and do not reach the environment; and
- Small spills from pipelines are likely to reach the environment.

Onshore or offshore refined-oil spills could occur along ice roads, or from barges, helicopters, airplanes, gravel pad facilities, or trucks along the road system. Typical refined products spilled on the North Slope are aviation fuel, diesel fuel, engine lube oil, fuel oil, gasoline, grease, hydraulic oil, transformer oil, and transmission oil. On the North Slope, diesel spills account for 61% of refined oil spills by frequency and 75% by volume.

Based on the total oil production projected in **section 4.2.1.2** and historical North Slope spill data, the estimated number of small crude oil/refined oil spills for alternatives A, B, C, and D, are 516/1,276, 596/1,474, 721/1,782 and 659/1,628, respectively. (See Appendix K, Tables K-3 and K-4, for an accounting of how the number of spills and spill size are projected using historical spill rates and projected production rates).

Table 4.2-I. Assumed Small (<500 barrels) Crude/Refined Oil Spills for Life of Northeast National Petroleum Reserve – Alaska

Alternative	Estimated Number of Small Spills[1]	Estimated Total Small Spill Volume (bbl) [1]	Percent Chance of One or More Small Spills
A	516/1,276	1,548/1,016	>99.9
B	596/1,474	1,788/1,140	>99.9
C	721/1,782	2,163/1,417	>99.9
D	659/1,628	1,977/1,293	>99.9

[1] The first number is for crude oil spills, while the second number is for refined oil spills.
The estimated number of oil spills is based on the estimated volume of resources multiplied by the Alaska North Slope spill rate. See Appendix K for a detailed explanation.

4.2.2.3 Fate and Behavior of Spilled Oil

This section describes the properties and behaviors of spilled oil that must be considered when evaluating the potential effects of an oil spill in the various environments of the planning area.

Fate and Behavior

The primary processes that affect the fate of spilled oil are spreading, evaporation, dispersion, dissolution, and emulsification (Boehm 1987; Payne et al. 1987; Lehr 2001). These processes, collectively called weathering, dominate during the first few days to weeks of a spill, and, with the exception of dissolution, can dramatically change the nature of the oil. A number of longer-term processes also occur, including photo and biodegradation, auto-oxidation, and sedimentation. However, these longer-term processes are more important in the later stages of weathering and usually determine the ultimate fate of the spilled oil.

The chemical and physical composition of oil changes with weathering. Some oils weather rapidly and undergo extensive changes in physical and chemical composition, whereas others remain relatively unchanged over long periods of time. As a result of evaporation, the effects of weathering are generally rapid (i.e., occurring in 1 to 2 days) for hydrocarbons with lower molecular weights. Degradation of the higher weight fractions is slower and occurs primarily through microbial degradation and chemical oxidation.

The spreading of oil on water reduces the bulk quantity of oil present in the vicinity of the spill, but increases the spatial area over which effects from oil may occur. Thus, oil in flowing systems (as opposed to contained systems) would be less concentrated in any given location, but may cause impacts over a much larger area. Spreading and thinning of spilled oil also increase the surface area of the slick, enhancing surface-dependent fate processes such as evaporation, degradation, and dissolution.

Evaporation is the primary mechanism for loss of low molecular weight constituents and light oil products. As lighter components evaporate, the remaining petroleum product becomes denser and more viscous. Evaporation tends to reduce oil toxicity but enhance persistence. Hydrocarbons that volatilize into the atmosphere are broken down by sunlight into smaller compounds. This process, referred to as photodegradation, occurs rapidly in air, and the rate of photodegradation increases as the molecular weight increases.

Dispersion of oil increases with increasing surface turbulence. The dispersion of oil into water may serve to increase the surface area of oil susceptible to dissolution and degradation processes, and thereby limit the potential for physical impacts.

Dissolution of oil in water is not a major process controlling the oil's fate in the environment. However, it is one of the primary processes affecting the toxic effects of a spill, especially in confined water bodies. Dissolution increases with 1) decreasing molecular weight, 2) increasing temperature, 3) decreasing salinity, and 4) increasing concentration of dissolved organic matter.

Emulsification, the incorporation of water into oil, is the opposite of dispersion. During emulsification, external energy from wave action causes small drops of water to become surrounded by oil. In general, heavier oils emulsify more rapidly than lighter oils. The emulsified oil may remain in a slick, which can contain as much as 70% water by weight and can have a viscosity a hundred to a thousand times greater than the original oil. Water-in-oil emulsions often are referred to as "mousse."

Photodegradation of oil increases with greater solar intensity. It can be an important factor in causing the disappearance of a slick, especially one composed of lighter products and constituents; however, it is less important during cloudy days and can be nonexistent during the winter months on the North Slope. Photodegraded constituents of petroleum products tend to be more soluble and more toxic than their parent compounds. Therefore, extensive photodegradation, like dissolution, may increase the biological impacts of a spill event.

In the immediate aftermath of a spill, natural biodegradation of oil is not typically an important process controlling the fate of oil in water bodies previously unexposed to oil. Microbial populations must become established before biodegradation can proceed at any appreciable rate.

Overall, because the environmental fate of released oil is controlled by many factors, its persistence is difficult to predict with great accuracy. Besides the primary processes discussed in the preceding paragraphs, major factors affecting the environmental fate include the type of product, spill volume, spill rate, temperature of the oil, terrain, receiving environment, time of year, and weather. For example, because of their properties, both diesel and refined oil evaporate at a substantially faster rate than crude oil.

The characteristics of the receiving environment, such as type of land; the surface gradient; and whether it is marine or freshwater, surface or subsurface, spring ice overflow, summer open water, winter under ice, or winter broken ice, would affect how the spill behaves. In ice-covered waters, many open water weathering processes occur; however, the ice changes the rates and relative importance of these processes (Payne et al. 1991).

The time of year in which a spill occurs also has a major effect on the fate of the crude oil, as it is linked to climatic factors such as temperature of the air, water, or soil; depth of snow cover; whether there is ice or open water; and the depth of the active layer. During winter, the air temperature can be so cold that it modifies the viscosity of the oil, limiting its spreading, and sometimes even causing it to gel. The lower the ambient temperature, the less crude oil evaporates, as demonstrated experimentally by both Prudhoe Bay and Endicott crudes (Fingas 1996). Frozen ground limits the depth of penetration of any spill, and ice acts as a barrier to penetration until it melts.

Spills on Tundra

Oil movement over the ground surface follows the topography of the land (i.e., oil flows downhill). In general, oil flows until it reaches a surface water body or a depression, or until absorption prevents further movement. Oil flowing over land can infiltrate vegetative cover, soil, and snow. If released onto tundra, oil can penetrate the soil as a result of the effects of gravity and capillary action, with the rate of penetration depending on the season, the nature of the soil, and the type of petroleum product. In summer, spills can penetrate the active layer (the layer of soil and rock that thaws each summer and freezes each winter, which overlies the permafrost layer of permanently frozen soil and rock) and then spread laterally on the frozen subsurface, accumulating in local downturns. From there, the oil can penetrate into the permafrost (Collins et al. 1993). Precipitation may increase penetration into thawed soils/active layer (Solntseva 1998 in Chuvilin et al. 2001).

In winter, when the ground and water surfaces are frozen, spreading is controlled by the snow cover or frozen soil. Snow cover can act as an absorbent, slowing the spread of oil or preventing the spill from reaching the tundra surface. Therefore, oil tends to spread on the surface of the frozen soil, and penetration of oil into the soil is limited. However, any soil pore space that is not filled with ice may allow spilled oil to move into the frozen soil (Yershov et al. 1997; Chuvilin et al. 2001).

Tundra relief on much of the Coastal Plain of the North Slope is low enough to severely limit the spread of spills. During summer, flat coastal tundra develops a dead-storage capacity averaging a depth of 0.5 to 2.3 inches (Miller et al. 1980), which would retain 300 to 1,500 bbl of oil per acre. Even at high-water levels, the tundra vegetation tends to limit the spread of oil, with both vegetation and peat functioning as sorbents that allow water to filter through, trapping the more viscous oil (Barsdate et al. 1980), but making recovery of the oil more difficult. On the other hand, even small spills can be spread over large areas if the spill event includes aerial, pressurized discharge. With the high-velocity, bi-directional winds on the North Slope, oil can be misted miles downwind of a leak. For example, in December 1993, an ARCO drill site line failed, and 1 to 4 bbl of crude oil misted over an estimated 100 to 145 acres (Ott 1997). Additionally, in late May or early June, the ice in the northern Alaska rivers breaks up, causing a rapid flood event termed “breakup,” that, combined with ice and snow damming, can inundate large areas in a matter of days. A spill during breakup could be spread over a significantly larger area by the flooding water.

Spills into Water

Oil spreading on the water surface (but not necessarily the transport of oil by moving water) would be restricted in most planning area waters. Because of the increased viscosity (a property that reduces spreading) of oil in cold water, oil spills in planning area lake, river, and marine waters would spread less than those in temperate fresh or marine waters. The exception to this rule would be a spill in shallow, marshy, or ponded tundra or flooded lake margins during summer, which could spread similarly to a temperate spill. These shallower waters can reach temperatures up to 64°F, which is generally warmer than other tundra waters (Miller et al. 1980), and warm enough to lower oil slick viscosity.

Oil spilled onto the ice surface is prevented from spreading rapidly by the presence of snow and natural small-scale ice roughness (Dickins et al. 2000). An oil spill in broken ice would not spread as far as one in open water, particularly in the initial stages of a spill. Oil would spread between ice floes into any gaps greater than about 3 to 6 inches (Free et al. 1982).

Environmental conditions can be highly variable during fall freeze-up and spring break-up. The environmental conditions encountered during freeze-up are different than those encountered during break-up, and the behavior of ice during break-up and freeze-up is complex, varying greatly from year to year and from site to site. Additionally, at freeze-up and break-up, the timing and duration of ice break-up, and ice formation/decay processes differ greatly between shallow nearshore locations and deeper water sites (Dickins et al. 2000).

An oil spill under ice typically behaves in the general manner described below:

- The oil rises to the under-ice surface and spreads laterally, accumulating in the under-ice cavities. Because of under-ice storage capacity and low under-ice currents, oil spilled under stable landfast ice does not spread more than a few hundred feet from the spill site.
- For spills occurring when the ice sheet is still growing (typically from freeze-up until April), the pooled oil is encapsulated in the growing ice sheet. The presence of any substantial coverage of developing ice limits the spreading of spilled oil, as compared to a similar spill in open water.
- During break-up, as the ice begins to deteriorate, the encapsulated oil rises to the surface through brine channels in the ice (Glaeser and Vance 1971; Keevil and Ramseier 1975; NORCOR Engineering and Research 1975; Purves 1978; Martin 1979; Dickins and Buist 1981; Kisil 1981; Buist and Dickins 1983; Comfort et al. 1983; Dickins et al. 2000).

The spread of oil under ice can be affected by the presence of currents, if the magnitude of those currents is large enough. Laboratory tests have shown that currents in excess of 6 to 10 inches per second are required to strip oil from under-ice depressions (Cammaert 1980; Cox et al. 1980). Current speeds in the nearshore Beaufort generally are less than 4 inches per second during the winter (Weingartner and Okkonen 2001), speeds that were shown to be insufficient to strip oil from under an ice sheet after the oil had ceased to spread in field study near Cape Parry in the Northwest Territories (NORCOR Engineering and Research 1975). The area of contamination under ice could increase if the ice were to move. However, because the nearshore Beaufort Sea is in the landfast ice area, the spread of oil due to ice movement would not be anticipated until spring breakup.

With knowledge of the time of year and the expected ice conditions, one can predict the likely configuration of oil spilled under, in, on, or among ice with a fair degree of confidence, which can be used to plan appropriate strategies for monitoring and responding to spills (Dickins et al. 2000).

Weathering processes generally would be similar in freshwater and coastal marine regimes, with seasonal ice cover capable of greatly slowing weathering in both regimes. During winter, weathering of oil depends primarily on whether the oil is exposed to the atmosphere.

Evaporation of oil generally correlates to temperature, with lower temperatures linked to slower evaporation rates of crude oil (Fingas 1996). Oil between, or on, ice is subject to normal evaporation; oil that is frozen into the underside of ice, however, is unlikely to undergo any evaporation until the spring, when the deterioration of multi-year ice causes the encapsulated oil to rise to the surface through brine channels in the ice. For oil spilled during freeze-up, with the likely absence of wave action, evaporation is the only major weathering process (Dickins et al. 2000). Evaporation occurs as oil is released to the surface. Because freshwater and first year ice do not have enough salts to form brine channels, oil is released only as the ice surface melts to the level of the encapsulated oil. For freshwater ice, evaporation occurs when the ice

becomes porous within about 2 weeks of meltout (from May to July, depending on weather, ice thickness, and location of the oil in the ice). In multi-year ice, oil typically does not surface until August, with some oil not released until the following summer.

Dispersion of oil spills in water occurs from wind, waves, currents, or ice. Any waves within the ice pack tend to pump oil onto the ice. Some additional oil dispersion occurs in dense, broken ice through floe-grinding action. More viscous and/or weathered crude oil may adhere to porous ice floes, essentially concentrating oil within the floe field and limiting the oil dispersion. North Slope crude oil readily emulsifies to form stable emulsions, a process that is sometimes increased in the presence of ice. With floe grinding, Prudhoe Bay crude forms a mousse within a few hours and much more rapidly than in open water.

In most cases, the weathering processes acting on oil in and along streams or rivers are similar to those described above for freshwater or marine spills. The dynamics of a river or stream environment, however, have additional effects on the fate and behavior of spilled oil. Oil entering rivers and streams begins to spread as in freshwater or marine spills, but the spreading motion is rapidly overcome by the surface current, at which point an elongated slick forms. The oil flows downstream at the speed of the current in the absence of wind effects. In general, oil tends to accumulate in areas of quiet water or eddies at the inside of river bends on a meandering river or stream, or in other pools where velocities are slower. Pools of oil may also accumulate behind log or debris jams. Water near the center of a stream channel flows faster than water near the banks or bottom of the channel where the retarding forces of friction with the channel are greater. This difference in current speed and the resulting shearing forces between water layers is typically the major mixing mechanism that spreads a slick out as it moves downstream. The resulting shearing of the oil distribution along the axis of flow controls the plume shape and size, and the distance over which the oil concentration remains above a particular level of concern. The leading edge of the slick may move as a relatively sharp front (at the mid-channel current speed); however, mixing continuously exchanges water and oil between the slower, near-bank regions and the faster-flowing, center regions of the river. From a practical point of view, this means that although it might be possible to predict the initial arrival of oil at a point along the river, it is considerably more difficult to estimate when the threat is past, since the areas of slower currents may continue to supply oil to the main stream channel, even after the leading edge is past (Overstreet and Galt 1995).

Shear-dominated flows cause another effect that characterizes river spills. Shear in currents along the banks and river bottom is typically the major source of turbulence in rivers, in contrast to surface-wave activity in oceans. Mixing and dispersion caused by the interaction of the shear and the turbulence can move large amounts of oil below the surface (particularly if it is relatively dense, such as a heavy No. 6 oil, or if it is finely distributed as droplets). The shear-dominated river regimes tend to produce spill distributions having higher subsurface oil concentrations than would be expected in marine spills (Overstreet and Galt 1995). This turbulence increases with increased velocity of flow and bed roughness.

The National Petroleum Reserve – Alaska Oil-Spill Experiment

In July 1970, 5 bbl of Prudhoe Bay crude was experimentally spilled in a 0.07-acre tundra pond in the NPR-A near Barrow (Miller et al. 1978; Barsdate et al. 1980; Hobbie 1982). The general behavior of this experimental spill is instructive about what would be expected from a small spill in the planning area during the summer, or from a winter spill that melts out during thaw.

In this experimental spill, the oil spread over the water surface within a few hours to a 0.06-inch thickness. Within 24 hours, the slick thickened as lighter hydrocarbons evaporated, and shrank into a 10- to 16-foot band on the downwind side of the pond. For about a month, the oil moved back and forth across the pond, shifting sides with changes in wind direction. Gradually, the oil worked partway into the pond's vegetated margins. By the end of summer, all of the oil was trapped along the pond margins either on the water's surface or on the bottom. No oil left the pond during the next spring runoff, despite substantial water throughflow. Half of the oil was estimated to have evaporated or degraded within a year, but the rest of the oil remained with little change for at least 5 years.

4.2.2.4 Spill Prevention and Response

Each permittee operating on the NPR-A is required to develop and operate in compliance with an approved Oil Discharge Prevention and Contingency Plan (C-Plan), as defined in Lease Stipulation 9 and ROP A-3. The plan must describe the spill prevention measures as well as spill response procedures. Each permittee is required to have sufficient trained personnel and clean-up equipment and supplies available to meet Federal, state, and NSB regulations. Sufficient equipment and trained personnel must be available at the site of the activity to provide immediate spill response. Additional equipment and personnel from other locations can be used, such as equipment and personnel made available through Mutual Aid Agreements from other spill response contractors, other North Slope oil fields, North Slope communities, or other sources. Each permittee is also required to have proof of financial responsibility from the State of Alaska (18 AAC § 75.240).

In the context of spill prevention, an activity site is an exploration site, drilling site, or production site, each with its ancillary facilities. Federal regulations that must be met include BLM oil and gas operating regulations (43 CFR Part 3160, Onshore Order Numbers 1, 2, and 6). These regulations address the prevention and control of oil spills and releases. Regulations 40 CFR Parts 110 and 300 address responses to spills or releases of oil and gas. Spill response requirements would be thoroughly addressed at the site-specific permit level. For example, an Application for Permit to Drill would be evaluated for spill response regarding storage of chemicals and hydrocarbons on site and oil spill prevention equipment, such as blowout prevention equipment and leak detection systems. These requirements are addressed in Onshore Order No. 2. The Alaska Oil and Gas Conservation Commission (AOGCC) is responsible for hydrogen sulfide (H2S) planning for drilling operations, and Onshore Order No. 6 addresses anticipated H2S releases. These conditions are all very site-specific. U.S. Coast Guard regulations may also apply to the transportation and transfer of oil to or from barges or vessels. Alaska Statutes Title 46, chapters 3 and 4 provide the ADEC with the authority to prevent and respond to oil discharges. In addition, AS 46.03 and 46.04 provide ADEC with civil, criminal, and administrative enforcement authorities. The ADEC regulations that apply to oil spill prevention, contingency planning, and response are found in the Alaska Administrative Code (18 AAC Chapter 75).

A spill response plan includes an action plan and a list of contacts in local, state, and Federal agencies with direct responsibilities in the event of a spill, as well as private companies that can be called on for further information or assistance. The environmental obligations of operators on a Federal onshore lease are described in BLM regulations in 43 CFR Part 3160, Oil and Gas Operating Rules. In addition, parts or all of several Onshore Oil and Gas Orders may apply, as necessary.

Regulations administered by the BLM and the AOGCC require an operator to maintain well control at all times during drilling and production. The BLM has been delegated the authority to ensure that all exploration or production wells are operated under control. In the unlikely event that control of the well is lost (e.g., a blowout), the BLM would oversee all actions needed to bring the well under control.

BLM has the authority to cite the operator and bring civil and/or criminal charges for specific violations. If there is a spill or release of petroleum fluids or chemicals used in the petroleum industry on the lease, unit, or a participating area, the BLM has the authority to cite the operator and direct cleanup of the spill. However, cleanup would be completed in cooperation with other Federal or state agencies.

For spills on most lands within the state, ADEC is responsible as the State On-Scene Coordinator (SOSC). The USEPA serves as the Federal On Scene Coordinator (FOSC) for spills that reach inland waters, and the U.S. Coast Guard is FOSC in tidewater areas and on the seas. The FOSC and the SOSC must ensure compliance with all Federal and state laws pertaining to oil spill response and clean-up. The intent of applicable laws and regulations is to prevent, as much as possible, hazardous materials from entering water, and to ensure the rapid removal of these substances from areas where there is a danger of contaminating water. The FOSC and the SOSC, in coordination with the surface-land manager, monitors and documents the operator's actions and determines when the cleanup is satisfactory.

An exploration or production facility operator is required to include plans for the control and containment of spills, including blowouts, in the ADEC-approved contingency plan. The ADEC requires that all oil-spill prevention and contingency plans rely on control, containment, and cleanup of spills as the primary response tools. In situ burning is a spill response technique that can be considered and may be used, upon approval, in appropriate circumstances. The 1999 U.S. Coast Guard Caps Review recognizes in situ burning as "the only effective countermeasure for broken ice conditions."

Alaska statutes and ADEC regulations require that an operator of an oil exploration or production facility, a terminal facility (storing 5,000 bbl of crude oil or 10,000 bbl of non-crude oil), an oil tank vessel or oil barge, a non-tank vessel of more than 400 gross tons, or a crude oil pipeline have an Oil Discharge Prevention and Contingency Plan approved by ADEC before beginning operations (AS 46.06.030 and 18 AAC § 75.400).

Facilities that must have an ADEC-approved contingency plan must meet oil discharge prevention requirements found in 18 AAC § 75.005 - 75.090. Required prevention measures include training programs, operating procedures, monitoring, inspections, and equipment/facility specifications. All crude oil transmission pipelines must meet the leak detection, monitoring, and operating requirements of 18 AAC § 75.055.

Under these state requirements, operators must plan to contain or control an oil spill within 72 hours and to clean up a spill in the shortest possible time, consistent with minimizing damage to the environment. Environmental conditions can sometimes limit response work. Severe weather conditions in the Arctic, such as broken ice and extreme wind, can pose challenges to spill cleanup and containment. Realistic maximum response operating limitations must be taken into account in spill planning (18 AAC § 75.425(3)(D)).

Operators of facilities that must have an approved contingency plan and operators who drill for shallow natural gas (3,000 feet below ground surface or less) are also required by ADEC to provide acceptable proof of financial responsibility for the cleanup of oil spills (18 AAC § 75.240).

4.3 ALTERNATIVE A

4.3.1 Air Quality and Climate

4.3.1.1 Activities Not Associated With Oil and Gas Exploration and Development

It is anticipated that air quality impacts would continue to occur from diesel-fired generators in small villages, residential heating, snow machines, all-terrain vehicles, occasional small aircraft, limited local vehicle traffic, and occasional open burning. Given its high latitude, the planning area will continue to be subject to occasional air quality impacts from emission sources in northern Europe and Asia (and to a lesser extent, northern Alaska.). In addition, helicopter and fixed-wing aircraft activity are likely to occur each summer. Additional flights would originate out of Deadhorse, Prudhoe Bay, Barrow, and other airfields on the North Slope. These activities would have a transitory effect on local air quality.

4.3.1.2 Oil and Gas Exploration and Development Activities

Air Pollutant Emission Sources

The following air pollutants would be produced during activities associated with oil and gas exploration and development under all Alternatives: nitrogen oxides (NOx), sulfur dioxide (SO_2), particulate matter (PM, including both $PM_{2.5}$ and PM_{10}), and volatile organic compounds (VOC). Combustion emissions may be assumed to be primarily $PM_{2.5}$, while fugitive dust emissions may be assumed to be primarily PM_{10}. The types and amounts of air pollutants generated vary according to the phase of activity.

Regardless of development phase, it is anticipated that helicopter use would occur throughout the planning area, however CO is the primary air pollutant which would be emitted.

During the exploration/delineation phase, emissions would be produced by: 1) drilling equipment required for exploratory and delineation wells; 2) trucks and other vehicles used to support exploration; and 3) intermittent activities such as mud degassing and well testing. Pollutant emissions would consist primarily of CO, NOx, and SO_2, and are assumed to be minimal under Alternative A.

During the construction phase, the principle emission sources include: 1) drilling engines/turbines; 2) heavy construction equipment used to install well modules and pipelines; and 3) ground-based support vehicles and aircraft. The primary development-phase emissions would be CO and NOx, with lesser amounts of PM and SO_2.

During the production phase, the primary source of emissions would be power generation for heating, oil pumping, and water injection. The emissions would consist primarily of CO and NOx, with smaller amounts of PM. There would also be minimal evaporative losses of VOC from oil/water separators, pump and compressor seals, valves, and storage tanks. Venting and flaring could be an intermittent source of NOx, VOC and possibly SO_2.

In addition to these criteria pollutants, certain hazardous air pollutants (HAP) may also be emitted. Benzene, toluene, ethylbenzene and xylenes are common HAP associated with volatilization of oil and gas resources, as is formaldehyde from compressor engines. Depending on conditions, hydrogen sulfide may also be found in oil, however an accurate determination of specific HAP quantities and potential impacts is not feasible at this stage, given that particular site-specific development activities and pollution controls are not yet able to be predicted

Effects of Air Pollution

As presented in Table 3.2-B of Chapter 3, **section 3.2.2**, ambient air quality standards have been established for seven air pollutants in order to prevent significant air quality impacts from occurring and thus protect human health and welfare. In addition, the U.S. Congress established Prevention of Significant Deterioration increments, which limit the increase of NO_2, PM and SO_2 values above legally established baseline concentrations.

Under the State Implementation Plan, the ADEC has jurisdiction for regulating and permitting air quality emissions within the planning area. Operators would be required to meet ADEC's requirements for air emissions, including obtaining construction and operating permits. All BLM activities (whether directly or through use authorizations), must comply with all applicable air quality laws, regulations, standards, increments, and implementation plans.

In general, air quality effects could be short term (hours, days, or weeks), long term (seasons or years), local, or regional (North Slope). Significant impacts from directly emitted air pollutants are not likely to occur. Ozone forms photochemically from the interaction of NOx and VOC in the presence of sunlight and heat. Although sunshine is prevalent in the planning area during the summer, temperatures are relatively low, and individual field development activities would be separated from each other, increasing atmospheric dispersion of pollutants and inhibiting the formation of ozone. However, without project specific proposals, along with representative meteorology, air quality, and terrain data, it is not possible to quantitatively predict potential localized air quality impacts.

Once site-specific projects are submitted for authorization, potential air quality impacts could be reduced by limiting the emission sources (fuel characteristics, engine specifications, etc.), spacing (such as separating concurrent drilling operations to reduce combined impacts), limiting the season and timing of operations (to enhance favorable dispersion conditions), and requiring specific control measures (road watering, low NOx flares, etc.)

Native Views on Air Emissions

Leonard Lampe, former Nuiqsut mayor, has reported air pollution problems and habitat concerns, asserting that Nuiqsut has been experiencing air pollutant effects for some time: "A lot of air pollution, asthma, bronchitis, a lot with young children. We see smog pollution that goes from Prudhoe Bay out to the ocean and sometimes to Barrow when the wind is blowing that way" (Lavrakas 1996). Because of the distances from the most likely developments to Nuiqsut and the relatively small sizes of these projects in comparison with the Prudhoe Bay complex, air pollutant emissions associated with Alternative development is expected to have a moderate effect with respect to these observations.

Air Pollutant Emissions

Air pollutant emission estimates for Alternative A (No Action) were based on the following information sources:

1. Helicopter emissions were based on the Federal Aviation Administration's Emissions and Dispersion Modeling System (EDMS version 4.1) for a Bell 206 (Edwards, 2007);
2. Emission estimates developed for the Alpine Satellite Development Plan (USDOI BLM, 2004c) for satellite well pad/access road construction, fixed wing aircraft flights, drilling rigs, and specific production equipment (satellite heaters, field generator, and a CPF turbine); and
3. Actual 2006 air pollutant emissions from the ConocoPhillips Alpine Production Facility (Poteet, 2007).

These emission factors were adjusted for the following assumed activities under Alternative A:

1. Helicopters: 5,000 one-hour flights per year;
2. Exploration/Delineation: up to 144 fixed wing flights per year, 86 exploration wells and 65 delineation wells, 5 drill rigs;
3. Construction: 3,395 fixed wing flights per year, 2 drill rigs, 3,270 acres of land disturbance; and
4. Production: 672 fixed wing flights per year, 23 satellite well pads, 5 Central Production Facilities, and 74 MMbbl peak annual oil production.

Based on these emission factors and anticipated activity, the maximum annual emissions (in tons per year) by activity phase are presented in Table 4.3-A.

Development and production activities can also produce fugitive dust emissions (primarily as PM_{10}). Fugitive dust occurs primarily during the summer months due to driving on unpaved roads. Vehicles can also track out fine material from gravel mining operations in the winter and summer months. Potential control measures include limiting vehicle speeds, and treating problematic road sections with surfactants or water.

Well closure, abandonment and rehabilitation activities would emit air pollutants similarly to those during development (construction), since similar vehicles and other emission sources would be used. Because closure activity would not occur at a single location for any substantial length of time, the impact of air emissions at any single location would be minor and short term. Impacts could be minimized by leaving gravel on-site, limiting the amount of transport. Once reclamation is complete, production facilities would no longer impact North Slope air quality.

In comparison, a site-specific air quality impact analysis was conducted for the off-shore Liberty Project (USDOI MMS, 2002), which would be somewhat smaller than a typical field that could be developed in the planning area, which demonstrated ambient air quality levels would be close to, but within applicable PSD Class II increments. The combined facility concentrations plus background were predicted to remain well within the ambient air-quality standards (between 2 and 30% of the standards). Because Alternative A (No Action) facilities would have similar air emissions as those predicted for the Liberty Project, it is likely potential satellite well pads and central production facilities would have similar air quality impacts. However, the accuracy of determinations of specific air pollutant emissions and potential impacts is necessarily limited at this stage, given that particular site-specific development activities are not yet able to be predicted.

Since CO_2 has not been regulated as an regulated air pollutant, potential CO_2 emissions were not specifically calculated for Alternative A. However, assuming an average 98% combustion efficiency, the CO emissions reported in Table 4.3-A may be multiplied by 80 to estimate equivalent CO_2 emissions (a maximum of 19 x 10^4 tons per year.) However, when compared to estimated worldwide emissions of CO_2 (nearly 28 x 10^9 tons per year), Alternative A (No Action) would contribute minuscule amounts of CO_2 emissions to global levels.

4.3.1.3 Effectiveness of Stipulations

No air quality lease stipulations were included for Alternative A. Potential air quality impacts from site-specific development activities would be limited based on air quality permits issued by the ADEC and EPA, including applicable control technologies.

4.3.1.4 Conclusion

Air quality impacts from Alternative A are likely to remain below applicable ambient air quality standards and increments, therefore no significant impact to air quality is expected. Air pollutant emissions associated with Alternatives A are less than any other Alternative. Each new exploration or development activity, or production area, would result in an additional air pollutant emissions. However, a determination of specific air pollutant emissions and potential impacts can not be made until site-specific development activities are proposed. As exploration and development activities cease, or production sites are shut-in, there would be a corresponding decrease in air emissions.

Table 4.3-A. Alternative A Air Pollutant Emissions from Surface Activities (tons per year)

Activity Phase	Carbon Monoxide	Nitrogen Oxides	Particulate Matter [1]	Sulfur Dioxide	Volatile Organic Compounds
Helicopters	10	1	1	<1	<1
Exploration/ Delineation	30	133	7	15	<1
Construction	81	295	20	24	26
Production	2,316	12,027	281	381	271
Total	2,437	12,456	309	420	298

Source: Archer, 2007
[1] Combustion sources primarily emit $PM_{2.5}$ while land disturbance primarily emits PM_{10}.

4.3.2 Paleontological Resources

Paleontological resources (plant and animal fossils) are nonrenewable. Once they are impacted or displaced from their natural context, the damage is irreparable. While much of the planning area is underlain by paleontological resources, most of these resources are of the marine plant and invertebrate variety and are so numerous that the potential impacts addressed here do not present a substantial threat. Vertebrate fossils are much less common and are more likely to be impacted by the activities associated with oil and gas exploration and development.

4.3.2.1 Activities Not Associated With Oil and Gas Exploration and Development

Under Alternative A, some paleontological research and excavation could be conducted annually by permit within the planning area. Excavation is a destructive activity; however, it is necessary for the recovery of scientific data. Excavation and collection normally occur during the summer, and are typically the result of paleontological and geological research; however, on occasion paleontological material has been inadvertently discovered as a result of archaeological research. Most paleontological material is buried considerably deeper than archaeological material and is therefore not regularly encountered by chance. Some Pleistocene-age animal remains could be recovered in archaeological deposits if the deposit were old enough. In such situations, the remains would represent subsistence use of the animal(s) by humans. The faunal material would be considered part of both the archaeological record and the regional paleontological record.

Aircraft and watercraft traffic, summer camps, hazardous and solid waste material removal and remediation, overland moves, and recreation associated with non-oil and gas activities would all have effects on paleontological resources. While aircraft use would not directly affect paleontological resources; it could have an indirect effect by making paleontological resources more accessible to recreation and other users, which can lead to unauthorized collecting and inadvertent damage.

The temporary summer field camps commonly associated with scientific or resource assessment work, hunting, or river float trips generally impact relatively small areas. Therefore, such camps and the activities associated with them, such as aircraft use, on-the-ground survey and reconnaissance, hazardous and solid-waste material removal, site remediation, and recreation, would have only a minor effect on paleontological resources.

4.3.2.2 Oil and Gas Exploration and Development Activities

Effects of Disturbance

The drilling of exploration wells and delineation wells would typically occur during winter. It is expected that no more than five wells would be drilled at any one time. Drill pads, camp pads, roads, and airstrips made of ice and snow would be used, but no permanent pads, roads, or airstrips would be constructed; therefore, no major ground disturbance would occur and buried paleontological material would not be impacted. The only substantial subsurface disturbance that would occur as a result of the actual drilling would be the making of the borehole itself. Were scientifically important paleontological material present at the site of the borehole, these resources could be impacted by the drilling process. However, the likelihood of such an occurrence is extremely small.

Surface disturbance from construction of CPFs and associated satellite pads, roads, airstrips, pump station, and gravel pits could impact as much as 3,270 acres. The primary impact to paleontological resources would result from the excavation of mineral material (gravel) for construction of the permanent facilities. Extraction of gravel could impact paleontological resources. Pleistocene vertebrate fossils are commonly recovered during gravel-mining operations on the North Slope. It is anticipated that the pipeline would not have associated all-weather roads or pads and would be constructed during the winter months from ice roads and pads. Therefore, the only substantial impact resulting from aboveground pipeline construction would be associated with the placement of VSMs. Depending on the depth at which the VSMs were set it is possible, though highly unlikely, that paleontological resources would be impacted. If a pipeline was placed underground, an additional 1.5 acres per pipeline mile would be disturbed. Overall, disturbance from development would have a very low probability of impacting paleontological resources.

It is unlikely that paleontological resources would be impacted by abandonment activities, as these areas would have been previously disturbed by construction and development activities.

Effects of Spills

An estimated 65–80% of all spills are confined to a pad, with the remainder generally confined to an area adjacent to the pad. During exploration, it is assumed that most spills would occur on an ice pad or ice road during winter conditions, resulting in cleanup that is less invasive than the cleanup required by a spill on land during summer. Paleontological resources typically are so deeply buried that they would not be affected by either a spill or subsequent spill cleanup. The effects of spills and spill cleanup associated with development would be similar to those associated with exploration activities except that they would occur during the snow-free months. Although cleanup from the spills could be more invasive because the ground surface would not be frozen, there is little chance that subsurface paleontological resources would be impacted. If present, surface paleontological material could be impacted as well. However, since the occurrence of important paleontological remains is rare, the probability of an impact is minor.

Commercial Gas Development

The types of impacts on paleontological resources that natural gas development and production would cause would be the same as those caused by oil development described above, except that there would be no crude-oil spills and if a gas pipeline is buried—the likely method—there would be additional acreage disturbed with increased potential for disturbance or destruction of paleontological resources. The highest potential for harm to paleontological resources would occur from digging a 4-foot-wide trench. For the 162 miles of pipeline anticipated under this alternative, that would impact approximately 80 acres. Indirect impacts could also occur on approximately 210 acres in areas adjacent to the trench from potential disturbance from machinery or placement of backfill. However, burial of the pipeline during winter will offer substantial protection to paleontological resources.

The risk to paleontological resources would be reduced dramatically if gas pipelines are put on VSMs rather than buried. In such a situation, paleontological resource impacts would be extremely low—limited to approximately 1.5 acres impacted by the VSMs themselves (assuming a separate set of VSMs are needed rather than using the VSMs associated with oil transportation) and disturbance associated with building a 10- to 20-acre compressor pad.

4.3.2.3 Effectiveness of Stipulations

The lease stipulations associated with waste prevention, handling and disposal, spills, overland moves, and seismic work generally reflect the standard lease stipulations BLM commonly attaches to permits for seismic survey activities in the planning area. The agency would generally continue to impose these restrictions under Alternative A.

Lease Stipulations 24, 67, and 70 would provide protection from seismic and overland move activities that could potentially impact paleontological resources near the ground surface. Within the planning area, paleontological resources are most diverse and abundant along the Colville and Ikpikpuk rivers. Lease Stipulation 39 would prohibit the construction of permanent oil and gas facilities within and adjacent to waterbodies, which would protect exposed paleontological resources along the banks of the Colville and Ikpikpuk rivers. Lease Stipulation 74 would protect previously unknown paleontological resources by requiring a paleontological survey prior to any ground-disturbing activity. If paleontological material were discovered, all operations would be suspended until written authorization to proceed was issued by the appropriate authority. These lease stipulations would be highly effective in protecting known and previously unknown paleontological resources and preserving their research potential, and ensuring that impacts to paleontological resources would be minor.

4.3.2.4 Conclusion

Most paleontological material is deeply buried and is therefore not regularly encountered by chance. The drilling of exploration wells and delineation wells would occur during winter and these activities would have a minor impact on paleontological resources. The primary impact to paleontological resources would result from the excavation of gravel for construction of the permanent facilities, but surveys for paleontological resources would be conducted before excavation and similar ground-disturbing activities could take place. Overall, both non-oil and oil-related activities within the planning area have a very low probability of impacting paleontological resources.

Impacts to paleontological resources from non-oil and gas activities, and from oil and gas activities would likely be additive, except in those areas where the two activities overlapped. In areas where two or more activities occurred, overall impacts would reflect those impacts associated with the first activity and any new impacts associated with later activities. Because of the size of the disturbance area, the potential for impacts to paleontological resources from oil and gas development under this alternative would be about the same as Alternative B and three-quarters as much as Alternatives C and D, although the potential for impacts would be greater if exploration and development activities occurred in an area with an abundance of paleontological resources.

4.3.3 Soil Resources

4.3.3.1 Activities Not Associated With Oil and Gas Exploration and Development

Ground-impacting management actions within the planning area that could affect soils under Alternative A include aircraft use (landing and take off), use of off-highway vehicles (OHVs) such as snow machines and four-wheelers, and other ground-disturbing activities. Where activities did not alter vegetative cover, there would generally be only a small impact on soils.

However, where these activities concentrated surface disturbance (e.g., foot traffic around a landing site or repeated snowmachine crossing of a drainage channel at the same site), there could be damage to the soils. If the vegetative cover or surface organic mat was removed or disturbed, soil erosion and thawing of the permafrost could occur.

Soils naturally thaw during the warm months, resulting in an "active layer" that ranges in depth from 8 inches in poorly drained sites to 80 inches in well-drained inland gravel sites (NRC 2003). Variation is based on location, aspect, vegetation type, soil makeup, and amount of contained water. Depth of the active layer would also be affected by changes in the climate. Generally, the loss of vegetation cover would cause the greatest change in the thermal balance. However, compaction of the organic layer could also change the thermal balance to a lesser degree by reducing its insulating capacity. Soils containing ice could lose volume when thawing, resulting in subsidence, thermokarsting, and gullying.

Upon removal of the organic mat, soils could be transported by wind and water, which could deposit sediment into sensitive areas. Impacts from soil excavation and removal activities would be localized and probably not widely distributed. For soils containing large amounts of ice, however, the impacts would be greater. When warmed, ice-rich permafrost soils could slump and release melted water, creating ponds. Ponded water absorbs more radiant energy and increases the area of warming soils. This form of disturbance would continue well beyond the initial disturbance and take several years to decades to stabilize. However, the landscape can be altered permanently.

Off-runway landings by private or commercial wheeled aircraft could cause short-term damage to soils on the landing sites. However, most wheeled aircraft landings would occur on sand or gravel bars, or possibly on dry gravelly ridges. Impacts from such landings should be minor and sporadic in occurrence.

The use of OHVs, such as four-wheel vehicles and snowmachines, could cause localized impacts to tundra. Use of snowmachines during the winter, when the ground is frozen and there is adequate snow cover, would have little or no impact to the soils. The use of snowmachines during fall or spring, or in areas without adequate snow cover, especially when crossing streambanks, could result in damage to soils, leading to thermokarsting. Similarly, use of four-wheel vehicles on tundra could churn soil in the upper portion of the profile, leading to braided trails and thermokarst in wet tundra.

4.3.3.2 Oil and Gas Exploration and Development Activities

The following analysis is based on **section 4.2.1.2, *Oil and Gas Exploration and Development Activities***. See that section for a discussion of estimates and assumptions for development as well as a description of how estimated areas of disturbance were calculated for each alternative.

During oil and gas exploration and development, various activities could cause impacts to soil in the planning area. These activities include seismic activities; construction and use of gravel pads, gravel roads, gravel airstrips, and pipelines; excavation of material sites; and construction of ice roads and ice pads. Impacts could also occur from oil spills and from removal of gravel pads and gravel roads during rehabilitation. These activities would impact soil productivity and could alter the moisture regime of tundra near the structure by changing natural drainage patterns and areas where snow accumulates. In most cases the location, magnitude, and total

area of affected soils vary by alternative. However, types of impacts to soils from oil and gas activities under all alternatives are similar.

Embankments, such as work and camp pads, roads, and pump stations made from sand, gravel, or rock fragments, completely cover the natural soils and can cause their compaction. Landscape scarring resulting from working material sites, conventional pipeline construction, digging, excavation and placement of fill is particularly damaging in the Arctic because of the slow rate of pedogenesis (soil formation). Soils in the planning area are subjected to cold and anoxic conditions that retard pedogenesis, allowing exposed mineral soil layers to persist for decades. In addition, any disturbance that removes the insulating surface organic layer may result in differential thawing of the permafrost and cause thermokarst, subsidence, gullying and increased potential for soil erosion and sedimentation.

Effects of Disturbance

Seismic Surveys

Seismic surveys to collect geological data would occur during the winter months. Frozen ground and sufficient snow cover, along with the requirement for low pressure ground vehicles, would serve to prevent most disturbances to vegetation or compaction of the soils (Lease Stipulation 24). A majority of seismic surveys create minor, short-term disturbance to soils and vegetation (Jorgenson et al. 2003). However, even with protective stipulations in place, some small areas of disturbance to soils and vegetation would be expected to occur from seismic surveys and overland moves. In some instances past overland moves and seismic surveys have disturbed vegetation, altered the thermal balance, and increased the risk of thermokarsting (Jorgenson et al. 1996). Areas of disturbance could be caused at streambank crossings from damage to the vegetative mat which could be scraped away, leaving exposed soil. Disturbance could also be caused to vegetation on the tops of tussocks in dryer areas. Water saturated areas show less damage to vegetation and soils from large tired vehicles (USDOI 2005). The potential for soil erosion would increase with an increase in disturbance to soil and vegetation; therefore, the most effective mitigation would be to keep areas and severity of disturbance as small as possible.

The following analysis quantifies the potential impact of three anticipated 2-D surveys and two anticipated 3-D surveys. If advances in seismic survey technology make resurveying of already surveyed lands attractive, additional surveying could occur and add an undetermined amount of impacts. Under Alternatives A and D it is unlikely that seismic surveys would occur on Teshekpuk Lake. Two-D surveys are most likely in the foothills area. The length of 2-D surveys would be much shorter than normal, however, and the total length for all surveys would be approximately 250 miles. These surveys could be accomplished in as little as a season or two. The maximum area impacted by 250 miles of seismic lines would be 6,060 acres (Table 4.2-F). This figure is presented as a maximum, because not all of the area within a 200-foot-wide line actually would be overrun by a vehicle.

Trails are also made by camp-move vehicles, which traverse about the same distance as line miles of 2-D survey as well as traveling to and from the survey area. For analysis purposes, it is estimated that a round trip into the planning area to the site of seismic surveying and return would be 106 miles. A camp-move trail is about 12 feet wide, and it is assumed the camp train would involve two to three strings of trailers. These strings could use the same trail, but this would cause greater damage than to use separate trails, especially over dryer soils (USDOI 2005). For this analysis, it is assumed that on average, 2.5 camp-train strings would use

different trails to decrease overall damage and, therefore, camp-move trails effectively would impact a path 30 feet wide. Assuming that there would be three 2-D surveys that on average would require a roundtrip camp move of 106 miles, camp moves to and from seismic survey areas would potentially impact 1,156 acres. This would be in addition to 910 acres potentially disturbed by camp train moves along the total 250 miles of anticipated 2-D seismic. Therefore, the total number of acres affected by 2D seismic operations is estimated at approximately 8,100 acres (6,060 + 1,156 + 910) or 0.18 % of the planning area.

Three-D seismic surveying would have the potential to cause greater impacts to soil than 2-D seismic surveys since tighter turns by heavy equipment are required and have greater potential to disturb soils and vegetation. Approximately 98,880 acres would be covered by 3D surveys (Table 4.2-F). In addition, it is assumed that camp trains would move approximately 30 miles within the surveyed areas and 106 miles roundtrip to reach the sites amounting to an additional area covered of 990 acres. Therefore, the total number of acres affected by 3D seismic operations is estimated at approximately 100,000 acres (98,880 + 990) or 2.2 % of the planning area.

A majority of seismic surveys create minor, short-term disturbance to soils and vegetation. However, some studies on the effects of past seismic activities have shown a small percentage results in moderate to high, long-term impacts (Jorgenson et al. 1996, Jorgenson et al. 2003). The later study suggests that improvements in the equipment and procedures used for seismic surveys have reduced the amount of impact to tundra, resulting in a higher percentage of tundra in categories of minor or little to no impacts and few if any highly-impacted sites. Calculations of area impacted by seismic operations in this analysis use a maximum estimated area of disturbance, but it should be noted that the projected impacts are probably greater than actual impacts would be. See **section 4.3.5.2** under the vegetation section for a more thorough analysis of potential impacts to vegetation (and therefore potentially, soils) from seismic surveys.

Exploration

Under all alternatives, permanent or gravel oil and gas facilities including roads would not be constructed during the exploration phase of oil and gas development (Lease Stipulation 27). Limiting exploration activities to the winter season when the ground is frozen would prevent most damage to soils. However, the construction of ice pads for drilling exploratory or delineation wells and ice roads for accessing the pads could impact soils in the planning area. Soil compaction resulting from on-road vehicle traffic could increase localized ponding and permafrost degradation. Degradation of permafrost beneath heated infrastructure would initiate or exacerbate any impacts to the structural integrity of the overlying improvements.

In general, ice road and ice pad construction would have only localized impacts on soils, which would usually be limited to compression of the tundra under the ice roads and ice pads. In addition, a recent study of ice road impacts by BLM found that the wetter the area (evaluated during summer), the less damage to vegetation and soils from large tired vehicles (USDOI 2005). It is estimated that, on average, there would be 50 miles of ice roads through the planning area on an annual basis, impacting approximately 212 acres. For Alternative A, it is estimated that a total of about 5,200 miles of ice roads would be constructed during the life of the plan impacting approximately 16,000 acres (Table 4.2-G). Under Alternative A, the location of winter ice roads could be offset from year to year to minimize vegetative impacts. The offset would be greater than or equal to the width of the road (Lease Stipulation 18). In addition, approximately 20 miles of ice runway would be constructed impacting approximately 220 acres.

Multi-year ice pads could be used in a second winter, but would require insulation to prevent melting during the spring and summer. Some melting would likely occur around the perimeter of the pad, causing vegetation in this area to break dormancy. If plants breaking dormancy were covered by an insulating layer or by timbers or other material used to hold the ice pads insulating cover in place, they would die from the lack of sunlight (Noel and Pollard 1996, Hazen 1997, McKendrick 2000).

Under Alternative A, it is assumed that 86 exploration wells and 65 delineation wells, for a total of 151 wells, would be drilled from ice pads in the planning area. The total area of soil impacted by a typical ice pad (500 feet by 500 feet) would be approximately six acres. Therefore, a total of approximately 900 acres (151 wells at 6 acres per well) could be impacted by ice pads. The majority of these would be single-year ice pads and have only minor, short-term impacts to soils. Longer-term impacts would occur to soils under multi-year ice pads due to increased damage to vegetation. See the vegetation section for a more thorough discussion of impacts to vegetation from ice roads and ice pads. Furthermore, the construction of well cellars during exploration would require a hole to be dug, destroying vegetation on approximately 16 square feet (0.0004 acres) of ground. Construction of well cellars could create long-term impacts to a total of approximately 0.06 acres (151 wells x 0.0004 acres per well). As a result, soil loss and thermokarsting would likely occur in these small areas.

Placement of Gravel Fill

Under all alternatives, construction of CPFs and associated satellite pads, roads, pump station, staging bases, and airstrips would result in the loss of soil productivity in areas where gravel was placed. Placement of gravel fill directly on the tundra surface would decrease the porosity and permeability of the underlying soil. Development of this infrastructure for 5 CPFs under Alternative A would result in a total of approximately 2,700 acres of soil productivity lost by gravel placement.

Construction of gravel pads, roads, and airstrips could also result in indirect effects to soils by altering the moisture regime of tundra near the structure due to changing natural drainage patterns and areas where snow accumulates. Snowdrifts caused by gravel structures would increase the wintertime soil surface temperature and increase thaw depth in the soil near the structures. These impacts would be exacerbated by dust deposition and by the formation of impoundments. These factors could combine to warm the soil, deepen thaw, and cause thermokarst adjacent to roads and other gravel structures (NRC 2003, p 95). In flat, thaw-lake plains on the North Slope, gravel construction can be anticipated to result in upslope water impoundment and thermokarst erosion equivalent to the area directly covered by gravel (Walker et. al. 1987). In this analysis, approximately 2,700 acres could be covered by gravel under Alternative A. Therefore, the total area of soils impacted by gravel fill under Alternative A is estimated at approximately 5,400 (2 x 2,700) acres.

Material Sites

Under all alternatives, gravel required for development in the planning area could be mined from existing sites east of the NPR-A, or could be extracted from new sites developed within the planning area. Investigations to identify gravel sources in the NPR-A have been limited primarily to the sources near the Alpine field, including the ASRC Mine Site and Clover Potential Gravel Source (see **section 3.2.8.2, *Gravel Mine Sites***), but additional investigations would be initiated if discoveries of recoverable oil and gas were made. Under Alternative A, it is

possible that 11 gravel mine sites could be necessary, impacting a total of 550 acres (Table 4.2-G). Excavation of the gravel mine and stockpiling of overburden would require removal of overlying soils and create long-term impacts to soil productivity at gravel extraction sites.

Pipelines

Pipelines on the North Slope are typically built on vertical support members (VSMs) with a diameter of 12 inches and a spacing of 150 VSMs/mile. Under Alternative A, 392 miles of pipeline would be required, resulting in short term disturbance to soils of approximately 1,191 acres and a long term impact at VSM sites to a total of approximately 2 acres (Table 4.2-G).

In areas where pipelines were buried, construction of a trench would impact soil and temporary storage of overburden in adjacent areas would alter soil where temporary storage of the overburden occurred. The zone of impact would be approximately 12 feet wide for the length of the buried segment, and the total area of impact would be 1.5 acres per pipeline mile. Because pipeline burial under tundra has been the exception on the North Slope rather than the norm, it is expected that this activity would disturb only a small amount of area in the planning area.

Effects of Oil and Gas Development on Permafrost

Under all alternatives, oil and gas activities can have adverse effects to permafrost. Except for the active layer, which lies between the top of the permafrost and the ground surface and thaws each summer, the ground is permanently frozen to about 660 to 2,130 feet on the North Slope (NRC 2003). The permafrost contains varying fractions of ice, and it is this ice that supports buildings, roads, or pipelines placed on it. The amount of potential subsidence from thawing permafrost is proportional to the volume of ice contained in the soil. Ice content can vary widely in the planning area and is dependent on ice structure, soil texture, and type of terrain (Jorgenson et. al. 2003). Thus, in the planning area, structures must be designed to avoid thawing their own foundations. Roadways and buildings must be elevated on thick gravel berms or pads, or on pilings. Gravel berms for roads can be as high as six feet above the tundra surface to ensure that the subgrade remains frozen. These roads have visual impacts on the landscape, and can intercept natural drainage and create ponds that thicken the active layer and initiate thermokarst (Walker 1996).

Pipelines generally must be built on VSMs to ensure that the heat from the transmission of warm fluids does not thaw the surrounding permafrost, causing differential settlement. Heated buildings can also thaw the permafrost, leading to thaw settlement, if they are not elevated on pilings or their foundations insulated and refrigerated. On pads with closely spaced wells, extensive refrigeration with passive heat pipes and insulation is required to ensure that the heat from fluids does not melt the permafrost. It is standard industry practice to incorporate designs that minimize or prevent thawing of the permafrost. Under alternative A, less surface disturbance is expected from oil and gas activities as compared to the other alternatives (Table 4.2-G). Therefore, there would be less area of permafrost potentially affected.

Abandonment and Rehabilitation

Removal of aboveground facilities, pipelines, bridges, and power poles during the winter would have a minor impact on soils and permafrost under all alternatives. Soils and permafrost would remain unaffected for as long as pads and roads were maintained. Once maintenance of the roads and pads ceased, thaw subsidence in ice-rich areas would result in settling of the gravel structures into thermokarst troughs. Removal of the roads and pads would accelerate thaw

subsidence since the vegetation under pads would have been destroyed during construction. However, removal of the gravel would allow the reclamation process to begin. Under Alternative A, it is expected that fewer structures would be constructed for oil and gas activities as compared to the other alternatives (Table 4.2-G). Therefore, the amount of rehabilitation required, and impacts to soils from abandonment and rehabilitation, would be less than under the other alternatives.

Effects of Spills

Under all alternatives, spills could adversely affect soils in the planning area. Spills can create direct toxic effects to soil productivity, and depending on the season, soils can also be impacted by compaction and thermokarst during cleanup activities. A fairly large spill (4,800 bbls) occurred on the North Slope in 2006 and impacted approximately 2 acres of tundra (see **section 4.2.2, *Oil Spills***). Most Alaskan North Slope spills have been contained on gravel pads and roadbeds (NRC 2003), and most of those that have reached the tundra have covered fewer than 5 acres (USDOI BLM and MMS 1998).

The primary processes that affect the fate of spilled oil are spreading, evaporation, dispersion, dissolution, and emulsification (Boehm 1987; Payne et al. 1987; Lehr 2001). Oil movement over the ground surface follows the topography of the land (i.e., oil flows downhill). In general, oil flows until it reaches a depression where it may be retained, or until absorption prevents further movement. Oil flowing over land can infiltrate vegetative cover, soil, and snow.

If released onto tundra, oil can penetrate the soil as a result of the effects of gravity and capillary action, with the rate of penetration depending on the season, the nature of the soil, and the type of petroleum product. In summer, spills can penetrate the active layer (the layer of soil and rock that thaws each summer and freezes each winter, which overlies the permafrost layer of permanently frozen soil and rock) and then spread laterally on the frozen subsurface, accumulating in local downturns. From there, the oil can penetrate into the permafrost (Collins et al. 1993). Precipitation may increase penetration into thawed soils/active layer (Solntseva 1998 in Chuvilin et al. 2001).

In winter, when the ground and water surfaces are frozen, spreading is affected by the snow cover or frozen soil. Snow cover can act as an absorbent, slowing the spread of oil or preventing the spill from reaching the tundra surface. Therefore, oil tends to spread on the surface of the frozen soil, and penetration of oil into the soil is limited. However, any soil pore space that is not filled with ice may allow spilled oil to move into the frozen soil (Yershov et al. 1997; Chuvilin et al. 2001).

Tundra relief on much of the Coastal Plain of the North Slope is low enough to severely limit the spread of spills. During summer, flat coastal tundra develops a dead-storage capacity averaging a depth of 0.5 to 2.3 inches (Miller et al. 1980), which would retain 300 to 1,500 bbl of oil per acre. Even at high-water levels, the tundra vegetation tends to limit the spread of oil, with both vegetation and peat functioning as sorbents that allow water to filter through, trapping the more viscous oil (Barsdate et al. 1980), but making recovery of the oil more difficult. On the other hand, even small spills can be spread over large areas if the spill event includes aerial, pressurized discharge. With the high-velocity, bi-directional winds on the North Slope, oil can be misted miles downwind of a leak. For example, in December 1993, an ARCO drill site line failed, and 1 to 4 bbl of crude oil misted over an estimated 100 to 145 acres (Ott 1997). Additionally, in late May or early June, the ice in the northern Alaska rivers breaks up, causing a rapid flood event termed "breakup," that, combined with ice and snow damming, can

inundate large areas in a matter of days. A spill during breakup could be spread over a significantly larger area by the flooding water.

Upon detection, spills have been promptly contained and cleaned up as required by state, Federal, and NSB regulations (NRC 2003). Impacts that have occurred were judged to be minor, and natural and/or anthropogenic-assisted restoration has generally occurred within a few months to years. See **section 4.2.2, *Oil Spills*** for a more extensive discussion of the fate and behavior of spills, and for an estimate of potential future oil spills by alternative.

If seawater were used for enhancement of oil production, a saltwater spill could occur within the planning area. According to McKendrick (2000), brine spills kill plants on contact and increase soil salinity to the point that many species cannot survive. Unlike oil, salts are not biodegradable, and natural recovery occurs only after salts have leached from the soil. A saltwater spill would degrade soil productivity and have effects on salt-intolerant vegetation near the seawater pipeline. However, the amount of tundra habitat affected would likely be limited to a few acres or less. In the case of a saltwater spill on tundra, the water would likely be adsorbed into the vegetative mat or, in wet habitats, diluted with fresh water.

Under all alternatives, large spills may occur during the life of oil development that might proceed from leasing in the Northeast NPR-A. Large spill scenarios involve a 4,800-bbl crude spill from a pipeline or a 900-bbl crude or diesel oil spill from a gravel pad facility (see **section 4.2.2, *Oil Spills***). For analysis purposes, it is assumed that two pipeline spills will occur under Alternative A and that three such spills could occur under the other alternatives. A large spill from a planning area facility or pipeline could happen at any time during the year. Under Alternative A, it is expected that the risk of spills in the planning area would be less than in the other alternatives since less oil and gas activity is expected to occur (see **4.2.1.2**). Therefore, potential impacts to soils from spills would also be less under Alternative A.

Summer Tundra Travel

As a rule, summer tundra travel would not be permitted under Alternative A. Therefore, no impacts to soils in the planning area would be expected as a result of summer tundra travel.

Commercial Gas Development

The types of impacts on soils that natural gas development and production would cause would be the same as those caused by oil development described above, except that there would be no crude-oil spills. If a gas pipeline is buried, there would be additional acreage of soils disrupted with reduced soil productivity. Direct impacts to soils would occur from digging a 4-foot-wide trench. Indirect impacts could occur in areas adjacent to the trench from potential soil compaction, thermokarst, and disturbance of vegetation. The total width of direct plus indirect impacts would be approximately 15 feet. This equates to approximately 1.8 acres of soil disturbance for each mile of buried pipeline.

The estimated 162-mile long gas pipeline would impact about 80 acres of soils directly through excavation of a 4-foot-wide trench and, potentially, 210 acres through compaction, thermokarst, and other indirect effects. In addition, ice roads that may be associated with placement of the gas pipeline would have localized, short-term impacts on soils, which would usually be limited to compression of the tundra under the ice roads and damage to the tops of tussocks in dryer soils.

Soils thus disturbed in the ice-rich northern part of the planning area are more likely to experience thermal degradation and subsidence as a result. In this case, the soils would not be lost completely, but soil horizons as well as the thermal regime would be altered. Melting of ice in the soils would result and the filled area, normally mounded immediately after fill, would level over time as melt water migrates. Ponding, and potentially soil erosion, could occur if the trench surface subsides below the grade of the surrounding terrain over time. These impacts would be dramatically reduced if gas pipelines were put on VSMs.

4.3.3.3 Effectiveness of Stipulations

To protect soils in the planning area, the approval of most proposals for summer operations are limited. Because of the fragile nature of thawed tundra during the summer, permit sites are restricted to durable areas such as gravel bars, beaches, or existing gravel pads. Vehicles allowed for use in overland moves would exert low ground pressure and be permitted to travel only over snow-covered ground frozen to a sufficient depth to minimize soil and vegetation impacts. Many of the lease stipulations under Alternative A directly or indirectly limit potential impacts to soils in the planning area. Lease Stipulations 1, 4, 5 through 16, and 24(m,n) relate to waste prevention, handling, disposal, spills, and public safety. These lease stipulations would ensure that waste materials associated with exploration and development activities were properly disposed of, and help prevent impacts to soil from spills and mishandling of materials. They would also provide for rapid cleanup of spills, which would decrease the likelihood of impacts to soils. Lease Stipulations 18, 22, and 24(c, f, g, h, i, j, l) would limit impacts to soils associated with overland moves and seismic work.

Lease Stipulation 27 would minimize surface impacts from exploratory drilling by limiting activities to temporary structures such as ice pads, ice roads, ice airstrips and temporary platforms, unless permanent structures were absolutely required. Lease Stipulations 30, 31, 32, 40, and 48 would protect soils in the planning area by providing facility design and construction regulations that would limit the footprint of developments, provide protection from oil spills, place restrictions on the development of gravel pits and permanent roads, and ensure resource issues were considered in the placement of facilities. Lease Stipulation 58 would provide for removal of all oil and gas facilities at the time of field abandonment. Lease Stipulation 63 would help to minimize resource conflicts by providing appropriate orientation programs and training for facilities workers. Lease Stipulation 67 would minimize impacts to vegetation and soil resources.

4.3.3.4 Conclusion

Numerous technological advancements have been made during the decades of operations on the North Slope that have allowed current development activities to proceed with less environmental impact than previous operations (NRC 2003). However, some short-term disturbance and permanent long-term impacts to soils are inevitable. Soil stability depends on vegetative cover; where vegetation is disturbed, impacts on soil follow. Impacts to soil from management actions under Alternative A would involve short-term disturbance over fairly large areas and long-term disturbance of relatively small areas. However, all areas of soil disturbance would be small as a percentage of the entire planning area (see below). The duration of these impacts could range from one year or less for minor disturbance of soil and vegetation to decades if the soil was destroyed or permafrost thawing was extensive.

Impacts to soils in the planning area from non oil and gas activities would be minor and the same for all alternatives.

Impacts from seismic activities would be the same for all alternatives. Short-term impacts could occur on approximately 8,100 acres (0.18 % of the planning area) of soil from 2-D seismic surveys and 100,000 acres (2.2 % of the planning area) of soil from 3-D surveys during a 25-year period (Table 4.2-F).

Approximately 1,200 acres could be impacted short-term by pipeline construction. Short-term impacts would also occur from temporary ice roads, ice pads, and ice runways. A total of about 5,200 miles of ice roads could be constructed during the life of the plan impacting approximately 16,000 acres (Table 4.2-G). In addition, approximately 900 acres could be impacted by ice pads for exploration and delineation wells and 20 miles of ice runway would be constructed impacting approximately 220 acres. In total, potential short-term impacts to soils under Alternative A from exploration (excluding seismic activities) and development would be approximately 18,000 acres (0.39% of the planning area). This is less than the other alternatives due to less surface disturbance expected from oil and gas activity.

Oil and gas development and operation would affect soils by compacting and damaging soils under gravel pads, gravel roads, and gravel airstrips; excavating material sites; and constructing VSMs. These impacts would be long-term. Long-term direct and indirect impacts would occur on an estimated 5,400 acres of soils from field development, and 550 acres from gravel extraction activities. Therefore, these activities could result in long-term impacts to approximately 6,000 (5,400 + 550) acres or 0.13% of the planning area. In terms of scale, the overall impact to soils in the planning area would be minor. Although all soil map units identified on Map 3-5 could be impacted during oil and gas exploration and development, soils associated with map unit IQ6 (see **section 3.2.7, *Soil Resources***) would likely be most affected since they are located in the area having high oil potential. Potential long-term impacts to soils under Alternative A would be less than the other alternatives due to less surface disturbance from oil and gas activity.

Impacts associated with oil spills, the majority of which would be cleaned up immediately, could aversely affect soil resources for a few years to several decades depending on the quantity, location, and season of the spill. Under Alternative A, it is expected that the risk of spills would be less since less oil and gas activity would occur in the planning area compared with the other alternatives (see **section 4.2.1.2**). Therefore, potential impacts to soils from spills would also be less under this alternative.

As a rule, summer tundra travel would not be permitted under Alternative A. Therefore, only minor impacts to soils in the planning area would be expected as a result of summer tundra travel.

Impacts to soil resources from non-oil and gas activities, and from oil and gas activities, would likely be additive in most cases, except in those areas where the two types of activities overlapped. In these areas the total actual impact could be less than the sum of both impacts because some of the activity would occur on areas already impacted. Impacts to soil resources from exploration and development activities would also be additive, except where development activities occurred in areas previously disturbed during exploration. In areas where two or more activities occurred, overall impacts would reflect those impacts associated with the first activity and any new impacts associated with later activities. Impacts to soil resources from Alternative A could potentially be somewhat less than the other alternatives as some high-potential oil and gas areas would remain unavailable for leasing. See Table 4.2-G for a comparison of estimated total surface area disturbed by alternative.

4.3.4 Water Resources

4.3.4-a Surface Water and Groundwater Resources

4.3.4-a.1 Activities Not Associated With Oil and Gas Exploration and Development

Activities not related to oil and gas exploration have the potential to impact water resources. However, all of these activities have been ongoing for many years with minimal impact to water resources.

Temporary tent camps would be located on existing pads or on well-drained soils along river terraces or uplands, set back from the stream or lakeshore with minimal surface disturbance. Excavation and collection activities would be done by hand shovel over several square feet, with replacement of the vegetative layer once completed. Recreational activities permitted by BLM would follow the National Outdoor Leadership School's "Leave No Trace, Alaskan Tundra" program to minimize impacts to vegetation and to reduce wastewater, human waste, and solid waste disposal. Thus, permitted recreational activities would have minimal impacts on water resources in the planning area.

Winter occupation or travel would use low-ground-pressure vehicles and trailers (Rolligons) at temporary locations with adequate snow cover. All fuel, waste, and hazardous materials would be stored on site in accordance with ADEC guidelines, and removed seasonally. Gray water and human wastes would be handled in accordance with ADEC regulations, thus minimizing impacts to water resources.

Aircraft use could take place any time of the year in the planning area, but would be most common in the summer months because of better weather and the ability to use lakes for landing. Aircraft could be used to support recreation, surveying, scientific research, and transportation of personnel and supplies. The main impact expected from aircraft would be local fuel oil spills.

Under Alternative A, permanent landing facilities would not be permitted on lakes or streams, and watercraft use would be limited to the summer months for transportation, recreation, and supply purposes. As with aircraft, no permanent facilities to support watercraft refueling or repair would be permitted on lakes or rivers. Watercraft would have the same potential for local fuel oil spills or leaks as aircraft landing on lakes and rivers. Therefore, local impacts to water bodies from aircraft (float planes) and watercraft are possible, and would be expected to consist of local fuel oil spills. Aircraft and watercraft would be required to carry spill containment and clean-up materials, so these spills should be contained and removed relatively quickly.

Overall, non-oil and gas activities would have minor impacts to water resources under Alternative A. In addition, fuel oil spills would be contained and cleaned up quickly, in accordance with BLM and ADEC guidelines for use of aircraft and recreational vehicles in the planning area.

4.3.4-a.2 Oil and Gas Exploration and Development Activities

The main water resource issues for the planning area are discussed below. These issues have been raised and discussed in the 1998 Northeast IAP/EIS (USDOI BLM and MMS 1998), the Northwest IAP/EIS (USDOI BLM and MMS 2003), and the Alpine Satellite Development Plan

EIS (USDOI BLM 2004C). The following analysis is based on **section 4.2.1.2, *Oil and Gas Exploration and Development Activities***. See that section for a description of how estimated areas of disturbance were calculated for each alternative.

Effects of Exploration and Development

Seismic activities and overland travel. Seismic surveys have the potential for thermokarst (subsidence of the ground surface due to thawing permafrost) because vehicles that cross the tundra during the winter months may damage the vegetation and soil surface. Some studies have shown that a small percentage of these surveys have caused long-term damage to the organic mat. No long-term damage was noted from seismic trails, but approximately 5% of the camp-move trails resulted in moderate to high long-term impacts (Jorgenson et al. 1996, Jorgenson et al. 2003). Upon removing the organic mat, soils are exposed to erosion by wind and water. These forces could deposit sediment into water bodies. Seismic equipment and vehicles used today employ low-ground-pressure equipment and designs and have much less impact to the tundra than older equipment, but camp moves can still impact the tundra and cause thermokarst (WesternGeco 2003). Thus, modern-day seismic equipment has minimal impact to the tundra and a limited role in causing thermokarst.

Lease stipulations for Alternative A restrict winter overland travel (including seismic activities) to times when the frost depth is at least 12 inches and snow cover is at least 6 inches. This restriction would greatly reduce the potential for thermokarst and long-term impacts to the tundra. Other important lease stipulations to prevent thermokarst would be the restriction on bulldozing of trails and repeated use of trails, to avoid formation of ruts. These lease stipulations, along with the minor impact of modern seismic equipment, should be highly effective in minimizing thermokarst erosion of the tundra and transport of sediment to water bodies.

Ice Road and Pad Construction. Ice roads and ice pads are used extensively during the winter exploration season for access and for exploration drilling and testing. An average ice road is about 30 to 35 feet in width, and must be at least 6 inches thick to support heavy traffic. Ice roads require about 1 to 1.5 million gallons of water per linear mile and generally can be built at a rate of about 1.5 inches of thickness per day (USDOI BLM 1998b). Ice pads range in size from 3 to 10 acres and are usually about 1 foot thick to support the heavy drill rigs. An ice pad can require up to 2 million gallons of water to build. Water for ice roads and ice pads comes from lakes that are not completely frozen. An alternative to using water from lakes is to use aggregate ice chips from lakes. It takes less time to build an ice road or pad using the aggregate chips, but these chips require time to collect and transport.

Under the Alternative A, approximately a total of 5,162 miles of ice roads (15,642 acres), 151 exploration and delineation well ice pads (906 acres), and 20 ice airstrips (220 acres) would be constructed during the estimated exploration and development scenario resulting in a total of 16,768 acres of short-term surface disturbance (See **section 4.2.1.2**, Table 4.2-G). Approximately 50 miles of ice road would be needed each year under all alternatives resulting in the use of approximately 75 million gallons (MG) of water per year (50 miles x 1.5 MG/mile). Ice roads would be offset from year to year by at least the width of the road to minimize damage to the tundra. Ice road use would be limited to the winter season, with the months during which ice roads are allowed set each year by the Authorized Officer (AO). Similarly, ice pads would be limited seasonally and subject to approval by the AO. Impacts to the tundra under this alternative should be minimal and limited mainly to the spring when the ice roads and pads

would melt and add somewhat saline water to the shallow tundra pools. This impact would be temporary in nature since these ponds will be recharged by local snowmelt and runoff.

The only source of water for ice road/pad construction during the winter months in the planning area is unfrozen water that lies beneath the ice caps of both shallow and deep lakes. This water is somewhat saline because of the exclusion of ions during the freezing of the upper part of the lake. Water withdrawals from lakes have the potential to lower water levels if the removed water is not recharged by snowmelt, rainfall, or inundation by rivers following the removal. Previous studies have shown lakes to have fully recharged the following breakup after water removals in the winter (Baker, 2002; Hinzman, 2006). The possibility still remains that pumped lakes may not fully recharge the following summer, but is unlikely since most have sufficient recharge areas or connections to other streams or lakes. Withdrawal of water from streams and riverine pools is not allowed by the AO in the planning area under any of the alternatives during the winter months.

Ice Road/Pad Water Use. Water from lakes may be used for ice roads and pads and for drilling water and potable water at drilling facilities, but the volume of water taken from an individual lake depends on the depth of the lake and the presence of fish in the lake. Under all the alternatives, for fish-bearing lakes, water withdrawal would be limited to a maximum of 15% of the under-ice volume of the water (assuming 7 feet ice thickness) for lakes 7 feet deep or deeper. No water would be taken from lakes less than 7 feet in depth if known to be fish-bearing or connected to a fish-bearing stream. The AO could authorize water withdrawal from lakes less than 7 feet deep that are not connected to a fish-bearing stream, or are not subject to seasonal flooding by a fish-bearing stream.

Drilling & Camp Water Use. Drilling requires water for making drill mud slurries which provide general lubrication, cool the bit, transport rock cuttings to the surface, prevent sloughing from the sides of the drill hole, and provide a weighting medium to prevent the migration of oil and other fluids into the well. Potable water is also used for drinking and other domestic uses in the camp that accompany drill rigs. For example, a 10,000-foot drill test would require about 850,000 gallons of water for drilling and about 100 gallons/day per person (50 to 60 persons per camp) for the drill camp (USDOI BLM 1998b). During a 4 month drilling season, one well could require up to 1.65 million gallons of water. Drilling in the Alpine field used 21,000 to 63,000 gallons of water per day and 8.4 million to 14.7 million gallons of water over the 4 month drilling season (ARCO Alaska 1996).

Under Alternative A, water withdrawal from lakes for drilling water and potable water for camp use would be governed by the same lease stipulations as those for ice roads and pads, discussed above. Therefore, it is expected that impacts to water resources would be minor because of lease stipulations governing the amount of drawdown allowed in the lakes, and which lakes could be used as water sources.

Snow Compaction. Removal or compaction of snow can increase the depth of freezing on lakes, often by a foot or more. As a result, the water quantity available in a lake during the winter months is greatly reduced, and the salinity of the water beneath the ice can be increased.

Under Alternative A, snow compaction would be prohibited on fish-bearing lakes, except at ice road crossings. Therefore, this alternative is protective of lakes and streams. No impacts to ice thickness on fish-bearing lakes are expected as a result of oil and gas exploration and development activities.

Drainage Disruption. Natural drainage patterns can be disrupted when activities or structures divert, impede, or block flow in stream channels, lake currents, or shallow-water tracks. Blockages in areas with low flow capacity, especially culverts blocked by snow and ice, can result in seasonal and sometimes permanent impoundments (NRC 2003). The resulting inundation can affect tundra vegetation and possibly lead to thermokarst (Walker et al. 1987 a, b). Diverting stream or lake flow can also lead to increased bank or shoreline erosion and sedimentation. Proper siting and adequate capacity design of culverts, bridges, pipelines, and other surface structure are needed to minimize drainage problems during the spring snow melt.

Under Alternative A, drainages would be protected by the lease stipulations listed in Appendix D. These lease stipulations require setbacks from specified rivers (Lease Stipulation 39 and 41), require bridges rather than culverts for crossing major rivers (Lease Stipulation 42), and require that culverts used for small drainages have ample capacity to handle the flow of the drainage during spring breakup to avoid ice jams (Lease Stipulation 43). Thus, this alternative would minimize impacts to drainages from construction of permanent and temporary facilities related to crossing the drainage. Overall, impacts to drainages should be kept to a minimum under this alternative as a result of these lease stipulations.

Channel Erosion and Sedimentation. Any surface activities that disturb streambeds and stream banks or remove protective shoreline vegetation can lead to channel erosion, formation of meltwater gullies, and formation of alluvial fans in streams and lakes (Lawson 1986). Inadequate design or placement of structures, culverts, or bridges can alter natural sedimentation patterns, creating scour channels and channel bars in streams. Improper placement of gravel pads or fill can result in erosion from the pads or roads and transport of gravel to streams and lakes. Blockages or diversions caused by insufficient flow capacity of structures over streams can lead to washouts during spring breakup flooding. Activities that minimize erosion and sedimentation include limiting construction and transport activities to winter or periods of low-water and keeping culverts free of snow and ice (Walker et al. 1987 a, b).

Under Alternative A, channel erosion and sedimentation would be minimized by lease stipulations listed in Appendix D. These lease stipulations require setbacks from specified rivers (Lease Stipulation 39 and 41), require bridges rather than culverts for crossing major rivers (Lease Stipulation 42), and require that culverts used for small drainages have ample capacity to handle the flow of the drainage during spring breakup to avoid ice jams (Lease Stipulation 43).

Gravel Removal. Removal of gravel from areas near streams and lakes can result in changes to stream or lake configurations, stream-flow hydraulics, and lake shoreline flow patterns, erosion and sedimentation, and ice damming (NRC 2003). Locating gravel pits at a safe distance from streams and lakes would minimize these impacts.

Under the Alternative A, gravel removal would not be permitted in the active floodplain of a river, stream, or lake unless authorized by the AO (Lease Stipulation 40). It is possible that 11 gravel mine sites could be necessary, impacting a total of 550 acres (Table 4.2-G). The number and size of gravel mining sites would be kept to a minimum in the planning area, and, where possible, be designed so that wildlife could use them after mining was completed. These lease stipulations are protective of streams, rivers, and lakes and should keep impacts to floodplains to a minimum.

Pipelines. Pipelines have their greatest impact on water resources during the construction phase, primarily through the use of temporary impoundments and diversions that can cause sedimentation of streams. Since pipelines are expected to be constructed in the winter, however, little or no impacts to water resources are expected. Roads are necessary for access to construction equipment, and construction activities associated with installing and testing pipelines can have considerable impact on surface water resources during the summer months. After the construction phase, elevated pipelines are expected to have a minimal impact on water resources. Leaks from elevated pipelines have been relatively minor in the North Slope. Tundra relief on much of the Coastal Plain of the North Slope is low enough to severely limit the spread of spills (see **section 4.2.2, *Oil Spills***). Buried pipelines, which are less commonly used on the North Slope, could have potential thermokarst, subsidence, and erosion problems beyond the construction phase.

Pipelines on the North Slope are typically built on VSMs with a diameter of 12 inches and a spacing of 150 VSMs/mile. Under Alternative A, 392 miles of pipeline would be required resulting in short-term disturbance to soils of approximately 1,200 acres. Lease Stipulations 7, 9, 10, and 13 require that pipelines be designed to minimize leaks and that operators have spill prevention and clean-up plans and equipment in place. These lease stipulations are designed to minimize impacts to water resources from pipeline leaks. Therefore, impacts to water resources from pipeline leaks should be minimal under the Alternative A, unless a large oil spill or blow-out occurs. Then the impacts to water resources would likely be substantial.

Commercial Gas Development

If commercial gas is developed on the North Slope, impacts would be similar to those from oil development. The most notable additional impacts likely to occur to water resources from gas development would be associated with burying a gas pipeline. Potential impacts during burial of a gas pipeline could include temporary impoundments, diversions, and sedimentation. Buried gas lines also have potential thermokarst, subsidence, and erosion problems that could persist beyond the construction phase. If all work on the pipelines is done during winter, these impacts would be greatly reduced. Placement of the gas pipeline on VSMs would also obviate these impacts associated with pipeline burial, though there could continue to be impacts associated with ice roads, which would be utilized to build either an aboveground or buried pipeline.

4.3.4-b Surface Water and Groundwater Quality

4.3.4-b.1 Activities Not Associated With Oil and Gas Exploration and Development

It is expected that fuel spills would be the main source of potential water quality impacts from activities not associated with oil and gas exploration and development. Float planes and watercraft have the potential for small fuel oil spills. These spills should be relatively easy to contain and remove, except under adverse weather conditions. Human activities such as scientific excavations, hunting, camping, and fishing of lakes and rivers could result in contamination by human waste and wastewater. This contamination should be very localized and disperse quickly in the water body. Fecal contamination by wildlife would be a more common and serious impact to water quality than occasional local human waste contamination.

4.3.4-b.2 Oil and Gas Exploration and Development Activities

Potential surface water quality impacts for oil and gas exploration and development fall into three general source categories: accidental release of fuels and other substances (including oil spills), which could occur during both the construction and operation periods; reductions in dissolved oxygen and changes in ion concentrations in lakes used for water supply, which would occur mainly during construction but could also happen during operations; and increases in terrestrial erosion and sedimentation causing higher turbidity and suspended solids concentrations, which could occur during both the construction and operational periods. The following analysis is based on **section 4.2.1.2, *Oil and Gas Exploration and Development Activities***. See that section for a description of how estimated areas of disturbance were calculated for each alternative.

Effects of Exploration

Exploration activities that could affect water quality within the planning area under all alternatives would be seismic surveys; ice-road and ice-pad construction; and drilling-fluid storage and disposal. Oil spills would predominantly be attributable to development activities; therefore, spills will be discussed under the analysis of development impacts.

Seismic activities and overland travel. Under Alternative A, the ground must be frozen and average snow depth must be 6 or more inches prior to starting seismic operations (Note: Alternatives B-D do not require specific snow depth). This depth, which is the current operating requirement on the North Slope (except for BLM's new performance-based stipulations), would be sufficient to protect waterbodies and water quality, as well as the tundra mat. However, it is expected that the tundra mat would experience some long-term impacts from seismic surveys.

While extensive thermokarst erosion along recent winter seismic trails is seldom observed, impacts to vegetation and surficial compaction (precursors to thermokarst erosion) are still in evidence (Jorgenson et al. 2003). Where surface disturbance does occur, recovery of damaged seismic tracks takes many years (Walker et al. 1987a, b). Thermokarst erosion and associated effects on water quality could occur in high impact areas if damage to the vegetative mat was persistent. Recovery of a vegetative mat damaged during seismic activities, which would be necessary to improve water quality impacts, could take from a few years to decades. Thermokarst erosion can result in water features with high turbidity and concentrations of suspended sediment. To cause high turbidity, the peat mat must be sufficiently eroded to expose underlying mineral soils, and the mineral soils must be fine grained. These conditions would rarely occur, even where tracked vehicles were used in multiple summer passes.

Impacts from seismic activities are expected to be the same for all alternatives (Table 4.2-F.). A total of approximately 108,000 acres could be subject to seismic activity and camp moves (Table 4.2-F). Of this amount, approximately 26,000 acres would experience short-term impacts, while 153 acres would likely suffer long-term impacts from seismic surveys conducted during a 25-year period. (see **section 4.3.5, *Vegetation***, for detailed computations of affected acreage.)

Ice Road/Pad Water Use. The use of water for ice-road construction could affect water quality in several ways. First, the winter extraction of water or ice from lakes in the planning area could change lake water chemistry. While impacts to water quality from withdrawal of water from lakes for ice roads and pads in the planning area have been found to be minimal (Baker 2002; Hinzman 2006), additional studies may be needed in specific cases to protect water quality.

In coastal tundra waters, alkalinity is associated with the salt content, with increases and decreases in alkalinity paralleling those of salinity. Pumping water from a freezing lake would remove the more saline and more alkaline water from under the lake ice. During snowmelt, the removed waters would be replaced by less saline, less alkaline runoff water.

A second way that ice-road construction could affect water quality would be from the construction of roads over lakes that do not to freeze to the bottom. Many of these lakes are only a foot to a few feet deeper than the minimum 6-foot depth necessary to maintain some unfrozen bottom water in winter. An ice road across such an intermediate-depth lake would be designed to freeze the entire water column below the road, isolating portions of the lake basin and restricting circulation. With mixing thus reduced, isolated water pools with low oxygen could result. Dissolved oxygen concentrations could be reduced to below the 5-ppm dissolved oxygen standard needed to protect resident fish (ADEC 1997).

A third way that ice-road construction could affect water quality would be through changes in water chemistry along the roadbed during and after meltout. The water withdrawn from lakes to construct the roadway would be more saline than typical snowmelt waters. In addition, the salts frozen into the ice road would leach out of the ice prior to its melting during snowmelt, increasing the initial salt content of the meltwater. This effect could be measurable during initial snowmelt, but the effect on water quality should be minimal and localized, most likely expressed as a slight increase in salinity during initial snowmelt. Lease Stipulation 18 requires offsetting of winter ice roads to minimize vegetative impacts.

Drilling Water Use. The use of water for construction, drilling, and domestic (crew) needs could affect water quality, as discussed for ice-road construction. Impacts to surface water quality from exploration activities, including drilling, are expected to be minimal and both local and temporary in nature. Withdrawal of water from lakes should not affect water quality in the lakes, except for potentially affecting the salinity. Drilling fluids and wastes would be stored and disposed of following guidelines established by the ADEC, and effects to surface and groundwater quality would be negligible.

Drilling Fluids. A typical 10,000 ft well might use 630 tons of drilling mud and produce 820 tons of rock cuttings. There would be a minor impact from drilling fluids used in exploration, as mud pits and discharge of drilling fluids and produced waters would be prohibited. Muds and cuttings would be either disposed downhole or removed from public lands to ADEC-approved waste-disposal facilities. Produced waters would be reinjected into the well. Some washed cuttings could be used in gravel-road or pad construction. These cuttings could contribute to localized water contamination in the form of runoff from roads or pads if the cuttings were not adequately washed. Crude oil and waterflood pipelines would be aboveground, and their construction and physical presence would have a minor effect on water quality, unless a spill occurred (see below).

Effects of Development

Development activities that could affect water quality in the planning area include spills; excavation of material sites; stream crossings; summer tundra travel: and construction of gravel roads, pads, and airstrips.

Spills. The greatest risk to water quality from oil and gas activity in the planning area is the potential for spills. Spills could occur on and/or from pipelines, production pads, airstrips, roads, and bridges. Spills that leave the gravel pads and gravel roadbed could reach one or

more of several habitat types including wet and/or dry tundra, tundra ponds and lakes, flowing creeks and rivers, and potentially estuaries and the marine environment. Oil spills onto the tundra surface or into water bodies are the result of accidents and leaks within and around drilling and production facilities, or along pipeline routes.

The history of oil spills from Arctic drilling activities along the North Slope is available from the ADEC database and has been summarized in the **section 4.2.2, *Oil Spills*** and in Appendix K. Oil spills result from leaks, faulty connections, blow-outs, and small spills around active drilling operations. Numerous spills of less than 25 bbl have been reported, with 99% of all oil spills being less than 25 bbl. It is likely that oil spills in the planning area would generally be less than 25 bbl in quantity and average around 3 to 5 bbls, and that blowouts would be rare. Most oil spills, in the past have occured during production operations, rather than during exploration drilling (NRC 2003). Under Alternative A, the estimated number and volume of large and small spills would be less than the other alternatives since fewer high oil potential areas would be available for development (see **section 4.2.2.2** for estimated number and volume of oil spills by alternative).

The impact of a spill would depend on the type of spilled material and the quantity, location, and season of the spill. High water events will occur in spring and may occur in fall, depending upon weather conditions, which could also influence the environmental impact of a spill. In addition, high wind events could affect the aerial extent of impact from a high pressure release from a pipeline that sprays into the air. For example, in December 1993, an ARCO drill site line failed, and 1 to 4 bbl of crude oil misted over an estimated 100 to 145 acres (Ott 1997).

Applicable ambient-water-quality standards for surface water and groundwater of the State of Alaska are: 1) total aqueous hydrocarbons in the water column may not exceed 15 µg/l (0.015 ppm); 2) total aromatic hydrocarbons in the water column may not exceed 10 µg/l (0.010 ppm); and 3) surface waters and adjoining shorelines must be virtually free from floating oil, film, sheen, or discoloration. The State of Alaska criterion of a maximum of 0.015 ppm of total aqueous hydrocarbons in surface waters, about 15-fold greater than background concentrations, provides the easiest comparison and is used in this discussion of water quality. This analysis considers 0.015 ppm to be a chronic criterion, and 1.5 ppm, a 100-fold higher level, to be an acute criterion.

Major crude oil spills generally result in peak dissolved hydrocarbon concentrations that are locally and marginally at toxic levels. Effects of spills less than 1,000 bbl can be considered minor. A spill greater than or equal to 1,000 bbl could temporarily (for about a month) contaminate water above the chronic criterion of 0.015 ppm in an area 100,000 acres or larger. Concentrations above the 1.5-ppm acute criterion could occur over 10,000 acres or more during the first several days of such a spill.

Surface Oil Spills. The behavior of oil spills would likely be similar in fresh and marine waters. Because marine waters can have strong currents, the dispersal of the oil spill by currents would be rapid. Given the cold temperatures in the Arctic, oil spills in fresh water should not spread rapidly, unless they are driven by strong winds. Shallow, marshy, ponded, or flooded tundra during the summer months can reach temperatures of about 64°F (Miller et al. 1980), which would allow for a lower viscosity of the oil and a spreading of the oil spill. Spills into water bodies with broken ice would spread between the ice floes into any gaps greater than 3 to 6 inches (Free et al. 1982). Oil spilled into streams would be driven and dispersed by stream currents. The oil would be driven downstream, likely accumulating in quiet pools and along natural and man-made structures that impede or redirect flow in the stream. The oil slick

would move fastest along the centerline of the stream channel, where currents are the highest, leading to a dispersed oil slick elongated downstream. In near-bank areas, the oil slick would tend to accumulate, bind with sediments and vegetation, and become difficult to remediate (Overstreet and Galt 1995). This oil along the banks could be released at a later date and re-enter the main flow of the stream.

Shear-dominated flows can create a special type of oil slick in rivers and along shorelines. Shear in currents along river banks, river bottoms, and shorelines causes turbulence that results in mixing and dispersion of the oil and can drive large quantities of the oil below the surface (Overstreet and Galt 1995). This can lead to oil accumulation in sediments and along river bottoms and large quantities of oil moving below the surface and out of view of the clean-up crew.

The primary effect of a small spill on water quality in tundra ponds would be direct toxicity, rather than oxygen depletion or other secondary effects. However, dissolved-oxygen concentrations in tundra waters could be affected by spilled oil in summer. Long-term toxicity could result from a small spill. Small waterbodies, such as tundra ponds and small lakes, are more susceptible to oil spills than larger lakes. Long-term toxicity could result from a small spill, as shown in an NPR-A experimental pond spill. That spill killed the zooplankton, and the pond water remained toxic to more sensitive zooplankton species for 7 years (Miller et al. 1978; Barsdate et al. 1980; Hobbie 1982).

Lease stipulations listed in Appendix D limit hydrocarbon storage, major fueling activities, and facilities sitings within at least 500 feet from active floodplains of rivers, streams, and lakes. Because of these lease stipulations, refined-product spills of hydrocarbons would be limited and would be less likely to contaminate freshwaters.

Under Alternative A, there is little potential for a spill from oil and gas activities to affect water quality in Teshekpuk Lake as the area around the lake is not open to surface activity or is not available for oil and gas leasing.

Under-Ice Oil Spills. Oil spills under an ice cap have the added problem of the oil binding to the ice. Studies by Glaeser and Vance (1971), NORCOR Engineering and Research (1975), and Comfort et al. (1983) have shown that the oil rises to the under-ice surface and spreads laterally, accumulating in under-ice cavities. Spills that occur when the ice sheet is growing become encapsulated in the ice. In the spring, as the ice melts, the oil rises to the surface in brine channels within the ice. The spread of an under-ice oil spill may be dispersed by currents in excess of 6 to 10 inches per second (Cammaert 1980; Cox et al. 1980). If the ice is marine ice and moves during spring breakup, the oil contained with the ice moves with the ice. Thus, under-ice oil spills can be quite difficult to detect and especially difficult to remediate. Lease Stipulation 28 prohibits exploratory drilling in river, stream or lake beds.

Gravel Structures. Under all alternatives, construction of CPFs and associated satellite pads, roads, pump station, staging bases, and airstrips, would result in the loss of wetland productivity in areas where gravel was placed. Development of this infrastructure for 5 CPFs under Alternative A would result in a total of approximately 2,700 acres of wetland productivity lost by gravel placement.

Construction of gravel pads, roads, and airstrips has altered the moisture regime of tundra near the structure by changing natural drainage patterns and areas where snow accumulates. Snowdrifts caused by gravel structures have increased the wintertime soil surface temperature

and increased thaw depth in soils near the structures. These impacts have been exacerbated by dust deposition and by the formation of impoundments. These factors combine to warm the soil, deepen thaw, and cause thermokarst adjacent to roads and other gravel structures (NRC 2003). In flat, thaw-lake plains on the North Slope, one study in the 1980's found that past gravel construction resulted in upslope water impoundment and thermokarst erosion equivalent to twice the area directly covered by gravel (Walker et. al. 1987). However, cumulative impacts recently reported by the National Research Council found that the ratio of direct to indirect impacts from gravel structures such as roads was about one to one (NRC 2003, p 95). In this analysis, approximately 2,700 acres could be covered by gravel under Alternative A. Therefore, the total area impacted by gravel fill under Alternative A is estimated at approximately 5,400 (2,700 + 2,700) acres. Lease Stipulation 43 requires natural drainage patterns to be identified and maintained during and after construction to prevent impoundments or alteration of the hydrologic regime.

Summer tundra travel. Summer tundra travel would not be permitted under Alternative A. Therefore, no impacts to water quality in the planning area would be expected.

Stream Crossings. Rivers and creeks could be affected from construction and operation of roads, pads, and pipelines. These structures can block, divert, impede, or constrict flows. Blockage or diversions to areas with insufficient flow capacity can result in seasonal or permanent impoundments. Constricting flows can result in increased stream velocities and a higher potential for ice jams, ice impacts, scour, and streambank erosion. Impeding flows can result in a higher potential for bank overflows and floodplain inundation. Lease Stipulations 42, 43, and 44 provide guidance on the use of bridges and culverts and best management practices to ensure that the natural drainage pattern would be maintained.

Pipelines. Pipelines have their greatest impact on water resources during the construction phase, primarily through the use of temporary impoundments and diversions that can cause sedimentation of streams. Since pipelines are expected to be constructed in the winter, however, little or no impacts to water resources are expected. Roads are necessary for access to construction equipment, and construction activities associated with installing and testing pipelines can have considerable impact on surface water resources during the summer months.

After the construction phase, elevated pipelines are expected to have a minimal impact on water resources. Pipelines on the North Slope are typically built on VSMs with a diameter of 12 inches and a spacing of 150 VSMs/mile. Under Alternative A, 392 miles of pipeline would be required, resulting in short-term disturbance to soils of approximately 1,200 acres. Buried pipelines, which are less commonly used on the North Slope, could have potential thermokarst, subsidence, and erosion problems beyond the construction phase. Because pipeline burial under tundra has been the exception on the North Slope rather than the norm, it is expected that this activity would disturb only a small amount of area in the planning area.

Gravel Removal. Gravel required for development in the planning area could be mined from existing sites east of the NPR-A, or could be extracted from new sites developed within the planning area. Investigations to identify gravel sources in the NPR-A have been limited primarily to the sources near the Alpine field, including the ASRC Mine Site and Clover Potential Gravel Source (see **section 3.2.8.2, *Gravel Mine Sites***), but additional investigations would be initiated if discoveries of recoverable oil and gas were made. It is possible that 11 gravel mine sites could be necessary, impacting a total of 550 acres (Table 4.2-G). Excavation of the gravel mine and stockpiling of overburden could impact water quality locally by an increase in thermokarst and erosion at gravel extraction sites.

In recent decades, suction dredges have been used in the NSB to mine sand and gravel from the Colville River Delta at Nuiqsut; the Meade and Kokolik rivers; lakes at Atqasuk and Barrow; and lagoons at Barrow, Wainwright, and Kaktovik (Walker 1994). Dredging increased upriver bottom erosion by increasing the steepness of river slopes in the Colville River, but the primary environmental effect attributed to NSB dredging has been expansion of fish overwintering areas. Water quality, as evidenced by the healthy fish populations, does not appear to be affected by this dredging activity (Walker 1994). Because gravel is a scarce commodity, construction technology could be refined to lessen gravel use and associated impacts, although such alternatives are not assumed in this analysis.

Effects of Abandonment and Rehabilitation

Removal of facilities, particularly roads, bridges, and culverts, would likely cause increased sedimentation and erosion immediately after removal. Leaving pads, airstrips, roads, bridges, and culverts in place, particularly without future maintenance, however, would result in longer-term, higher levels of erosion, sedimentation, and upslope impoundment. Leaving the roads in place, but removing bridges and culverts and breaching the roads where culverts had been placed, would reduce upslope impoundment. Ponds would be formed from melting of ice wedges or other ice underlying the gravel facilities. Adverse effects from abandonment and rehabilitation would be less for Alternative A than for the other alternatives because areas of high oil and gas potential would remain closed to leasing, and therefore, less development would likely occur.

Commercial Gas Development

If commercial gas is developed on the North Slope, impacts to water quality would be similar to those from oil development, though there would be no oil spill impacts. The most notable additional impacts likely to occur to water quality from gas development would be associated with burying a gas pipeline. Potential impacts during burial of a gas pipeline could include temporary impoundments, diversions, and sedimentation. Buried gas lines also have potential thermokarst, subsidence, and erosion problems that could persist beyond the construction phase. If all work on the pipelines is done during winter, these impacts would be greatly reduced. Placement of the gas pipeline on VSMs would also obviate these impacts associated with pipeline burial.

4.3.4-b.3 Effectiveness of Stipulations

Numerous lease stipulations were developed for the 1998 Northeast IAP/EIS ROD to reduce or avoid impacts to water resources and water quality. Lease Stipulations 1-4 require solid waste reduction plans, prohibit burial of garbage and require proper disposal of pumpable waste. Lease Stipulation 5 regulates the proper disposal of domestic wastewater, drilling wastes, and produced waters. Lease Stipulations 7-14, prescribe oil spill prevention and response requirements. Lease Stipulations 15 and 24m prohibit fuel storage within the floodplain and require appropriate containment. Lease Stipulations 16 and 24n require fuel handling and refueling restrictions. Lease Stipulations 20 and 21 prohibit the removal of water from rivers and streams during winter, and restrict the amount of water that could be removed from lakes during winter for ice road construction to protect aquatic, fish, and waterfowl resources. Lease Stipulation 22 protects riparian habitat along waterways. Lease Stipulation 24 provides further protection to waterways from overland moves and seismic work. In most cases, exploratory drilling would be prohibited in rivers, streams, and lakebeds (Lease Stipulation 28), and

permanent oil and gas facilities would also be prohibited in the Teshekpuk Lake Surface Protection Area (Lease Stipulation 31). Lease Stipulation 32 requires the development footprint and associated gravel to be minimized by proper design of facility structures and roads. Lease Stipulation 40 restricts gravel mining sites to the minimum necessary to develop the field efficiently and are prohibited from siting within the active floodplain. Permanent oil and gas facilities are also prohibited near other important water bodies in the planning area to protect fish and other resources (Lease Stipulation 39), and within 500 feet of all other water bodies (Lease Stipulation 41). Lease Stipulations 42, 43, and 44 provide guidance on the use of bridges and culverts and best management practices to ensure that the natural drainage pattern would be maintained. Lease Stipulation 46 will minimize development within key wetlands to protect aquatic, floodplain, and riparian areas. Lease Stipulation 58 requires removal and reclamation of the developed site upon field abandonment.

4.3.4.4 Conclusion

Under all alternatives, this analysis shows that impacts to water resources from non-oil and gas activities would be minor. Most impacts from and oil and gas exploration would also be minor and short-term. Short-term impacts include water withdrawals from lakes for ice roads and ice pads. Seismic activities could result in thermokarst and erosion on approximately 153 acres during a 25-year period under all alternatives.

Impacts from development would include some long-term disturbance of streambanks and shorelines and subsequent melting of the permafrost that could result in erosion and sedimentation. These impacts could occur when gravel roads, gravel pads, underground pipelines, or other permanent facilities are constructed near these areas. Long-term impacts from development of CPFs, gravel roads, pads, runways, pump stations, and staging bases could have both direct and indirect long-term impacts of up to approximately 5,400 acres under Alternative A (Table 4.2-G). Both aboveground oil pipelines and buried pipelines could result in short-term impacts. Under Alternative A, 392 miles of pipeline would be required. After construction was complete, impacts from elevated pipelines should be minor. Buried pipelines would have potential thermokarst, subsidence, and erosion problems that could persist beyond the construction phase, and result in about 1.5 acres of long-term impacts per buried pipeline mile. Since most work is done during the winter when the tundra is frozen, construction impacts would be reduced.

Rivers and creeks could be affected from construction and operation of roads, pads, airstrips, and pipelines. These structures can block, divert, impede, or constrict flows. Blockage or diversions to areas with insufficient flow capacity can result in seasonal or permanent impoundments. Constricting flows can result in increased stream velocities and a higher potential for ice jams, ice impacts, scour, and streambank erosion. Impeding flows can result in a higher potential for bank overflows and floodplain inundation. In this analysis, less infrastructure would be required since less area of high oil and gas potential would be available for development. Therefore, the potential for blockages and diversion of flow would be less under Alternative A compared to the other alternatives.

Under Alternative A, 11 gravel mine sites could be necessary, impacting a total of 550 acres long-term (Table 4.2-G). This compares with 13,16, and 14 mine sites with Alternatives B,C and D, respectively. Excavation of the gravel mine and stockpiling of overburden could impact water quality locally by an increase in thermokarst and erosion at gravel extraction sites.

The greatest risk to water quality from oil and gas activity in the planning area is the potential for spills. Under Alternative A, the estimated number and volume of large and small spills would be less than the other alternatives since fewer high oil potential areas would be available for development. Spills could occur on and/or from pipelines, production pads, airstrips, roads, and bridges. The impact of a spill would depend on the type of spilled material and the quantity, location, and season of the spill. Oil spills could result in the impacted waters being toxic to sensitive species. The primary effect of a small spill on water quality in tundra ponds would be direct toxicity Oxygen depletion or other secondary effects could also occur. Long-term toxicity could result from a small spill. Small waterbodies, such as tundra ponds and small lakes, are more susceptible to oil spills than larger lakes. Under Alternative A, there is less potential than the other alternatives for a spill from oil and gas activities to affect water quality in Teshekpuk Lake as the area around the lake is not open to surface activity or is not available for oil and gas leasing.

Impacts to water resources from non-oil and gas activities, and from oil and gas activities, would likely be additive, except in those areas where the two types of activities overlapped. Impacts to water sources from exploration and development activities would also be additive, except where development activities occurred in areas previously disturbed during exploration. In areas where two or more activities occurred, overall impacts would reflect those impacts associated with the first activity and any new impacts associated with later activities. Numerous lease stipulations were developed for the 1998 Northeast IAP/EIS ROD, and these should be effective in reducing or avoiding impacts to water resources.

4.3.5 Vegetation

This section discusses the potential effects to vegetation that could result from management action in the planning area under the Alternative A. The following sections summarize the information previously presented in the 1998 Northeast IAP/EIS (USDOI BLM and MMS 1998), which has been amended with additional data from studies conducted since 1998, particularly for the Northwest IAP/EIS (USDOI BLM and MMS 2003). It has also been updated with a new scenario for "reasonably foreseeable development" of oil and gas resources.

4.3.5.1 Activities Not Associated With Oil and Gas Exploration and Development

Various types of activities not related to oil and gas leasing and development could affect vegetation in the planning area. Off-runway landings by private or commercial wheeled aircraft could cause short-term damage to vegetation present on the landing sites. Most wheeled aircraft landings would occur on sand or gravel bars or possibly on dry gravelly ridges. Therefore, impacts from such landings would likely be minor and sporadic in occurrence.

Archaeological and paleontological digs could impact vegetation but would probably be limited to relatively small areas. Depending on the location of the dig, it could be possible to remove sod such that it could be replaced once activities at the site were concluded, resulting in a temporary disturbance. However, many digs would result in the destruction of vegetation at the site. Overall, the extent of these activities would likely impact only a few acres in the planning area, spread out over several locations.

Camps associated with scientific studies, recreational use and other activities could result in trampling of vegetation from foot traffic and tent placement, and in small spills of stove or

generator fuel. These impacts would typically be temporary, lasting from less than one to several growing seasons. Recreational camps are often located on river bars where vegetation cover is low. It is likely that larger camps would be located on existing gravel pads, which mostly lack vegetation. The total land surface impacted by camps is expected to be small (less than 10 acres) and the sites would be scattered.

Overland moves occurring in the planning area typically involve traffic between Deadhorse and Barrow. Moves would occur during winter when the ground was frozen and covered with snow. Impacts to vegetation associated with transport vehicles depend on the type of vehicle, the vegetation type, and the snow conditions. In general, low ground-pressure wheeled vehicles have less impact than do tracked vehicles or sleds on skids. In wetter tundra areas, impacts are usually limited to “green” trails caused by compression of snow and dead plant material, where standing dead vegetation has been laid down leaving only newer, greener vegetation standing in the following summer. Such trails are often visible for one to several growing seasons. In general, wet areas may be less affected than dry areas (Walker 1996), and snow acts as a buffer against these impacts. Overall, vehicle tracks may affect vegetation, soil chemistry, soil invertebrates, soil thaw characteristics, and cause small-scale hydrologic changes (Kevan et al. 1995). Avoidance of areas with low snow cover, use of low ground pressure vehicles, dispersed traffic patterns, and minimizing sharp turns could help to minimize damage. However, tracked vehicles can disrupt the vegetation surface when making tight turns or by dropping the vehicle’s blade too deeply into the snow. In wet tundra this disruption can result in water accumulation and thermokarst. In drier tundra, travel over low shrubs can cause breakage and tussocks may be broken or crushed. If a trail across the planning area was about 100 miles in length, and 12 feet wide, it would impact about 150 acres of tundra. Severity of impacts would depend upon the actual location and type of habitat, but impacts could range from temporary to longer-term.

The use of OHVs such as four-wheel vehicles and snowmachines could cause localized impacts to tundra. Snowmachines used during the winter when the ground is frozen with adequate snow cover would have little or no impact to the vegetation. However, heavy use of a trail could cause compaction of vegetation. In addition, heavy use of snowmachines during fall and late spring or in areas without adequate snow cover could result in damage to the vegetative mat which may lead to thermokarst. Similarly, use of four-wheel vehicles and Argos (six to eight-wheeled vehicles) on tundra disrupts the vegetation and soils in the upper portion of the profile, leading to thermokarst in wet tundra and damage or death of plants in drier areas. The use of airboats in shallow marsh areas could also impact aquatic vegetation and soils, although if confined to the river channel, airboats would have no impact on aquatic vegetation.

4.3.5.2 Oil and Gas Exploration and Development Activities

Effects of Disturbances

Various activities associated with oil and gas exploration, development and production could impact vegetation in the planning area. These activities include seismic operations, exploration drilling, construction of ice roads and ice pads, gravel road, pad, and airstrip construction, and pipeline construction.

Exploration

The following analysis quantifies the potential impact of three anticipated 2-D surveys and two anticipated 3-D surveys. If advances in seismic survey technology make resurveying of already surveyed lands attractive, additional surveying could occur and add an undetermined amount of impacts.

Seismic surveys to collect geological data and exploration drilling activities would occur during the winter months. Seismic exploration would cause impacts to vegetation similar to those described previously for overland moves. 2-D survey lines vary in length, but for this analysis it is assumed a total of 250 miles of 2-D seismic data will be acquired in three separate operations with current technology. The maximum area impacted by seismic lines would be approximately 6,060 acres (250 miles by 200 feet wide). This acreage is presented as a maximum because not all of the area within the 200-foot-wide path would be overrun by a vehicle. Trails would also be made by camp move vehicles, which would traverse about the same distance as line miles surveyed (Emers and Jorgenson 1997). Additional trails would be made while traveling to or from the survey area. A camp move trail is about 12 feet wide, and typically involves a camp train with two or three strings of trailers. All trailer strings could use the same trail, but the resulting damage to vegetation would be more severe and longer lasting than if separate trails were used by each trailer string. For this analysis it was assumed that 2½ individual camp string trains would use different trails to minimize disturbance, thus impacting a total path 30 feet wide. Assuming the anticipated three 2-D surveys that on average would require a roundtrip camp move of 106 miles, camp moves to and from seismic survey areas would potentially impact 1,156 acres (3 times 106 miles by 30 feet wide). This would be in addition to 910 acres (250 miles by 30 feet wide) potentially disturbed by camp train moves along the total of 250 miles of acquired 2-D seismic lines. Thus the maximum total area impacted by the anticipated three 2-D seismic surveys would be approximately 8,126 acres. Although this amount of survey work could be accomplished over just one to two winters, it may not all occur in the first 1-2 winters of plan implementation.

It is assumed that each 3-D seismic operation would cover a total area of 600 mi² (384,000 acres) involving a grid pattern of source and receiver lines, with source lines being less than 50 feet wide and receiver lines being about 100 feet wide. Source lines would be spaced about 1,320 feet apart and receiver lines about 1,100 feet apart. For each square mile surveyed, a maximum of 24.2 acres would be impacted along the source lines, and 58.2 acres along the receiver lines, for a total of 82.4 acres per square mile (13% of the survey area). The maximum area affected would be 49,440 acres per each of two anticipated 600 mi² surveys. For 3-D surveys, the length of camp move trails would be less than those covered by 2-D surveys since a single move would occur down the center of the surveyed area. Camp move trails would impact about 109 acres (30 miles times 30 feet wide) of tundra within each survey area. If a camp train traveled a 106 mile roundtrip to reach and leave the survey area, this would affect another 386 acres per survey. It is anticipated that two 3-D surveys would occur in the planning area during the life of the plan, impacting a maximum of 990 acres by camp move vehicles and 98,880 acres by seismic lines for a total of 99,870 acres of disturbance (2.2% of the 4.6 million acres planning area). This figure is presented as a maximum because not all of the area within a path would be overrun by a vehicle and because source and receiver lines would overlap in some areas.

A study of tundra disturbance associated with seismic surveys on the eastern portion of the North Slope reported little to no disturbance of tundra on 11% of the study plots 1 to 2 years following seismic surveys that occurred in 1984-1985 (Jorgenson et al. 1996). Disturbance was considered low on 64%, moderate on 23%, and high on 2% of the plots used in this study. Eight

to nine years following a survey, little to no disturbance was reported on 97% of the study plots, and no areas of moderate or high disturbance remained. Tundra under camp move trails showed little or no disturbance on 22%, low disturbance on 52%, moderate disturbance on 24%, and high disturbance on 2% of study plots. Eight to 9 years of recovery reduced the disturbance level to little or none on 85%, low disturbance on 10%, moderate disturbance on 4%, and high disturbance on 1% of plots. Using these approximations of disturbance and recovery, approximately 1,515 acres of vegetation would experience moderate to high impacts from the three anticipated 2-D seismic surveys immediately following surveys, and 24,720 acres of vegetation from the two anticipated 3-D surveys. In addition, moderate to high impacts for activity due to camp move trails could be found on approximately 537 acres for 2-D and approximately 257 acres for 3-D surveys in the first summer following the surveys. Eight to nine years following surveys, moderate to high impacts could be reduced to zero for seismic lines, 103 acres for 2-D camp moves, and 50 acres for 3-D camp moves.

In a similarly designed but more recent study in the NPR-A, during the summer immediately following a 1999 seismic survey, the disturbance level to the affected tundra under seismic lines was little to none on 68% of study plots, low on 32%, moderate on 0% and high on 0% (Yokel, unpubl. data). After six years, recovery had reduced the disturbance level to little or none on 96% of study plots and low on 4%. On camp-move trails the disturbance level to the affected tundra was little to none for 17% of study plots, low for 17%, moderate for 43% and high for 23%. After six years, recovery had reduced the disturbance level to little or none on 37%, with low on 43%, medium on 13% and high disturbance on 7% of study plots.

A study conducted in 2001 in the summer following seismic work found little to no impacts to tundra under seismic lines on 30% of the plots studied (Jorgenson et al. 2003). Low impacts were found on 66% and moderate impacts were found on 4% of the plots; no plots were highly impacted. Camp move trails in this study had little or no impacts on 18%, low impacts on 54%, moderate impacts on 29%, and high impacts on none of the plots.

The 1999 and 2001 studies suggest that improvements in the equipment and procedures used for seismic surveys may have reduced the amount of impact to tundra, resulting in a higher percentage of tundra in categories of low or little to no impacts and few if any highly-impacted sites. However, this conclusion is confounded with potential differences among studies in terrain types, snow cover, or observers' visual estimates of impacts. Calculations of area impacted by seismic operations in this document use environmentally conservative numbers; the projected, long-term impacts are probably greater than actual impacts would be.

During exploration, the construction of ice pads for drilling exploratory or delineation wells and ice roads used to access the pads would impact vegetation in the planning area. In general, construction of ice roads and ice pads would have only localized impacts on vegetation, usually limited in wetter areas to compression of the tundra vegetation under the roads and pads and a shortened growing season for the plants in the following summer due to delayed melting of the ice in the spring. However, ice roads and pads could also cause breakage of shrubs and scuffing and crushing of tussocks in moist or drier habitats, and localized areas of plant death (Jorgenson 1999; Pullman et al. 2005; Yokel et al. in press). Recovery from most impacts to vegetation would be expected within a few years. Under Alternative A it is assumed there would be a total of 151 ice pads built for exploration and delineation wells. At six acres per pad, these would impact 906 acres of tundra, spread out over 50 years. It is also assumed that there would be 50 miles of ice road constructed through the planning area for exploratory drilling on an annual basis until all presumed large fields are discovered (50 years), and another 50 miles per year for ten years for development of each of five large discoveries. In addition, it is assumed

that ice roads will be used for the construction of sales-oil pipelines. Under Alternative A, it is assumed 162 miles of such pipeline would be built over two seasons, requiring 162 miles of ice road in each of those two years. Therefore, during two of the 50 years, 262 miles of ice roads would be built each winter under Alternative A. During the other 48 winters, only 100 miles would be built. The total acreage of short term disturbance from ice roads over 50 years would be 15,642. Since vegetation recovery from ice road impacts is expected within a few years (Yokel et al., in press), long-term disturbance from ice roads would be negligible. Although some evidence of crushed tussocks may still be apparent, new growth would preclude any exposed soils.

Ice airstrips are also used during exploratory drilling, and under Alternative A it is assumed that 20 ice airstrips would be constructed covering 11 acres each for a total of 220 acres. These airstrips are commonly built on the grounded ice of large lakes, but if they were built over tundra they would result in impacts similar to ice roads.

Multi-year ice pads allow use of the pad in a second winter, but require insulation of the ice pad to prevent melting during the spring and summer. Studies of vegetation recovery at an extended year ice pad found the vascular plant cover was still 34% lower than pre-pad cover two years after the pad melted (Noel and Pollard 1996). Additionally, some melting often occurs around the perimeter of the pad, causing vegetation at the perimeter to break dormancy. If plants breaking dormancy are covered by the insulating layer or by timbers or other material used to hold the cover in place, they die from the lack of sunlight (Hazen 1997, McKendrick 2000). In the past eight years of exploratory drilling in the NPR-A, 25 wells have been drilled and one over-summer ice pad has been used for rig storage. If future work follows the same percent, then 151 wells could result in the use of six over-summer pads, affecting 36 acres of tundra.

The construction of well cellars during exploration requires the digging of a hole that destroys vegetation on approximately 16 square feet (0.0004 acres) of ground, which replaces that vegetation with bare soils. Thermokarst associated with the disruption of the thermal regime in the surrounding soil may also change the vegetation type around the well collar to a wetter vegetation type. These impacts could result in 0.06 acres of vegetation being destroyed under Alternative A, assuming construction of 151 well cellars.

Development and Production

During oil development and production, various activities could cause impacts to vegetation in the planning area. These activities include construction of gravel pads, roads, airstrips, and pipelines, excavation of material sites, and construction of ice roads. Impacts of ice roads were discussed previously under the "Exploration" subheading.

Placement of Gravel Fill. Construction of CPFs and associated satellite pads, roads, and airstrips would result in the destruction of vegetation in areas where gravel was placed. The development scenario under Alternative A assumes that five CPFs and associated satellite pads and roads would be developed. In addition to these, it is assumed under Alternative A that five pump stations would be built on 20 acres gravel pads and 2 staging bases would be built covering 50 acres each. All gravel placement taken together would total 2,718 acres with all vegetation under it destroyed.

The passage of vehicle traffic over gravel pads and roads would result in dust and gravel being sprayed over vegetation within about 30 feet of the pad or road, and a noticeable dust shadow

out to 150 feet or more. Within 30 feet of gravel structures, the dust and gravel could smother vegetation. The effects of dust on vegetation include early snowmelt, reduced soil nutrient concentrations, lower moisture, an altered soil organic horizon, and higher bulk density and depth of thaw (Everett 1980; Walker and Everett 1987; Auerbach et al. 1997). These studies found that plant species richness was reduced near gravel structures, particularly in naturally acidic soils. A decrease in acidophilus mosses, some lichen species, and certain heath taxa altered species composition (Walker and Everett 1987). In areas that experience heavy dust fallout, native plant communities could be killed and replaced by early-successional colonizers and species more tolerant of the altered site conditions (including possibly non-native, invasive species). The magnitude of these effects would depend on the duration of dust exposure (i.e., traffic intensity) and the distance from the source. Traffic volume and speed would generally be minor on in-field roads in the planning area, which would limit dust impacts to vegetation. Alternative A assumes a total of 230 miles of in-field gravel roads and 5 miles of airstrips with a potential for a total perimeter of 470 miles. Within 30 feet of gravel fill, up to 1,709 acres of vegetation could be subject to smothering by dust and gravel, and another 6,836 acres could be affected by a dust shadow.

The material used for gravel fill could also impact vegetation near gravel structures. Saline material used as fill increases the salinity of water draining off of or leaching through the structure. Increased salinity at a site could alter the species composition of the plant community in the immediate vicinity of the gravel structure, shifting the community toward one comprised of species that are more tolerant of saline conditions (McKendrick 2000).

Construction of gravel pads, roads, and airstrips could alter the moisture regime of tundra near the structure by changing natural drainage patterns and areas where snow accumulates. Snowdrifts caused by gravel structures increase the wintertime soil surface temperature and increase thaw depth in soils near the structures. These impacts are exacerbated by dust deposition (described above) and by the formation of impoundments (described below). These factors could combine to warm the soil, deepen thaw, and produce thermokarst adjacent to roads and other gravel structures (NRC 2003). Additionally, these changes could alter the species composition of the plant community near gravel structures. In general, most changes in the plant community around gravel structures would occur within 164 feet of the structure (Woodward-Clyde Consultants 1983). If all effects were to occur within this zone, approximately 9,343 acres would be impacted under Alternative A. Note that this area includes the 8,545 acres affected by dust above, and is not in addition to it.

Blockage of natural drainage patterns can lead to the formation of impoundments. In the Prudhoe Bay oil field, impoundments covered 22% of a highly developed portion of the oil field and 3% of a broader portion of the oil field (Walker et al. 1987a). Impoundments, which would generally be confined to areas of wet and aquatic vegetation, could alter both the hydrology and species composition of wetlands. Plant productivity could increase biomass of a few species; or productivity may decrease, as a result of loss of plant communities to the development of deep, open water areas. In most cases, impoundments would lead to a decrease in plant species richness (Klinger et al. 1983; Walker et al. 1987a,b). The use of adequate cross drainage structures in gravel roads and attention to the natural drainage patterns during design of developments could help reduce impacts to vegetation from impoundments.

Material Sites. Gravel required for development in the planning area could be mined from existing sites east of the NPR-A, or could be extracted from new sites developed within the planning area. Investigations to identify gravel sources in the NPR-A have not been conducted, but presumably would be initiated if discoveries of recoverable oil and gas were made. Under

Alternative A it is assumed that 11 material sites, each affecting 50 acres, would be needed. This would cover a total area of 550 acres. Excavation of the gravel mine and stockpiling of overburden would destroy vegetation at gravel extraction sites.

Pipelines. Pipelines on the North Slope are typically built on VSMs with a diameter of 12 inches and a spacing of 55 to 70 feet. In addition to the vegetation displaced by the VSM, installation of VSMs disturbs a zone around the VSM that is approximately 20 inches wide. This zone of disturbance results from spoil material deposited around the VSMs and from thermokarst, which may result in a change in species composition around the VSMs. Approximately 0.03 acres of vegetation would be disturbed per pipeline mile. Under Alternative A, 230 miles of gathering lines and 162 miles of sales-oil pipelines would disturb 12 acres of vegetation through VSM placement.

Pipelines could also impact vegetation indirectly by altering snow accumulation patterns and by shading vegetation. Pullman and Lawhead (2002) found that most sites under the Alpine field and Tarn pipelines did not differ substantially from nearby background areas located upwind. At about 25% of the sites sampled, substantially more snow accumulated under the pipeline, and at about 18% of the sites substantially less snow accumulated under the pipeline. In general, the snow pack was most likely to be deeper under pipelines with an east-west orientation, and when pipeline clearance was reduced to below five feet.

Vegetation under a pipeline receives less direct sunlight during the growing season than does vegetation that is not under a pipeline. Therefore, there could potentially be a decrease of photosynthesis in plants growing under pipelines, and a reduction in heat absorption by the ground cover, leading to a shallower active layer. However, there are no data that specifically address these questions. In general, Arctic plants are limited by nutrient availability rather than photosynthesis, and it is unlikely that pipeline shading substantially impacts vegetation physiologically (Tieszen 1978, Billings 1987, Bliss 2000).

In areas where pipelines were buried, impacts to vegetation would be different. Pipeline burial would destroy vegetation where the trench was constructed and would alter vegetation in adjacent areas where temporary storage of the overburden occurred. “Hot oil” pipeline burial under tundra has been the exception on the North Slope rather than the norm, and this document does not assume any burial.

Air Pollution. Various activities associated with oil development and production emit air pollutants, including NOx, NO_2, NO, O_3, and SO_2. Numerous studies have addressed the impacts of these pollutants on both vascular and non-vascular plants, but there are few studies of air pollutant impacts on tundra vegetation. Kohut et al. (1994) measured air pollutant concentrations and their effects on vegetation adjacent to the Central Compressor Plant (CCP), where gas powered turbine pumps compress natural gas prior to injection, in the Prudhoe Bay oil field. The CCP is the largest source of nitrogen oxides in the Prudhoe Bay oil field, producing NOx, NO_2, and NO, as well as O_3 and SO_2. Emissions from the CCP did not have effects on the local vegetation. Results did show an increase in foliar nitrogen near the CCP, but no visible injury to plants was found. Physiological changes (photosynthesis and respiration) in plants were not apparent in either field or growth chamber experiments for any of the pollutant gases, even at concentrations greater than those measured near the CCP. It is unlikely that pollutant emissions associated with development in the planning area would exceed those of the CCP; therefore, detrimental effects on vegetation around these facilities would not be expected. Primary productivity in Arctic tundra, however, is often limited by nutrient supply, particularly nitrogen and phosphorus (Chapin 1978; McKendrick and Mitchell 1978; Chapin et al. 1980;

Chapin and Shaver 1985). Fertilization leads to higher productivity and changes in the structure of Arctic plant communities (Chapin and Shaver 1985, McKendrick 1997) and may alter carbon balance at the ecosystem level (Billings et al. 1984).

Abandonment and Rehabilitation

During abandonment activities, vegetation and wetlands would be impacted by dust fallout along roads, by ice roads and other off-road tundra travel associated with dismantling of pipelines and power lines, and by disturbance to vegetation adjacent to VSMs and power line poles during their removal. The level of impact from these activities would be roughly the same as that during construction if gravel fill was removed; impacts would be less if the gravel were to be left in place. If roads and pads were left in place, and especially if cross drainage across roads was not maintained, water impoundment would occur, and could alter plant communities as described for the construction period. It is also likely that the non-maintained roads would have occasional washouts, where tundra vegetation would be covered with washed-out gravel. Roads and pads, if left in place, would likely need to be revegetated with plants native to gravel bars and ridges in the Arctic (i.e., different from the plant communities surrounding the facilities). Revegetation activities could take several years, as initial attempts are not always successful. Removal of gravel from pads, roads, and airstrips could be mandated. Partial or complete removal of gravel can result in faster reestablishment of native plant growth, although establishment can take many years (more than a decade). In addition, thaw subsidence is difficult to predict, and complete restoration to preexisting conditions is not likely.

Effects of Spills

Spills of refined oil could occur during overland moves and seismic surveys. These spills would likely be small, averaging 3 to 5 gallons or less, and would affect small areas (less than 50 square feet). Contaminated snow would be cleaned up immediately upon discovery. A spill from a large storage tank, which would be much less likely, could impact up to 500 square feet. Overall, past spills of this size and type on Alaska's North Slope have caused minor ecological damage and ecosystems have generally recovered, with wetter areas recovering more quickly than drier areas (Jorgenson 1997, McKendrick 2000).

Typical refined products that are spilled on the Alaska North Slope include aviation fuel, diesel fuel, engine lube oil, fuel oil, gasoline, grease, hydraulic oil, transformer oil, and transmission oil. The extent of environmental impacts of a spill would depend upon the type and amount of materials spilled, the location of the spill, and effectiveness of the response. The majority of small spills would be contained on the gravel pad and would have no impact on vegetation. Approximately 20-35% of past crude oil spills have reached areas beyond pads. For this analysis, it was assumed that 27% of all spills would occur or reach beyond gravel pads. Most spills would happen during the winter and could be cleaned with minimal impacts to vegetation. If it is assumed that 60% of all spills would occur during the winter, approximately 11% of all oil spills would reach vegetation and have more than a negligible effect. Under Alternative A this would mean 197 of the 1,792 crude and refined oil spills assumed to occur over the life of the plan.

Most oil spills would cover less than 500 square feet (<0.01 acres). However, a spill event that includes an aerial pressured discharge can cover substantially more area as occurred at an ARCO drill site in 1993 when crude oil misted over an estimated 100 to 145 acres (Ott 1997). (Such a spill is a very low probability event, occurring less than once out of the total spills expected throughout the life of this plan. Thus its magnitude is not apparent in the following

acreages). Assuming the average spill would cover 0.1 acre, under Alternative A approximately 20 acres would be impacted substantially during the lifetime of development in the planning area.

Oil spills on wet tundra kill the moss layers and aboveground parts of vascular plants, and sometimes kill all macroflora at the site (McKendrick and Mitchell 1978). Damage to oil-sensitive mosses could persist for several years if the site were not rehabilitated. The length of time a spill would persist would be dependent upon soil moisture and the concentration of the product spilled. McKendrick (2000) reported that complete vegetation recovery occurred within 20 years on a wet sedge meadow without any cleanup. A dry habitat exposed to the same application supported less than 5% vegetative cover after 24 years. Overall, past spills on Alaska's North Slope have resulted in minor ecological damage and ecosystems have shown good potential for recovery because most of the habitat is wet (Jorgenson 1997).

If seawater were used for enhancement of oil production, a saltwater spill could occur within the planning area. According to McKendrick (2000), brine spills kill plants on contact and increase soil salinity to the point that many species cannot survive. Unlike oil, salts are not biodegradable, and natural recovery occurs only after salts have leached from the soil. A saltwater spill would have effects on salt-intolerant vegetation near the seawater pipeline, but the amount of tundra habitat affected would be limited to a few acres or less. In the case of a saltwater spill on tundra, the water would likely be adsorbed into the vegetative mat or, in wet habitats, diluted with fresh water.

Oil spill response training and cleanup may also impact vegetation. Trampling of vegetation and stockpiling of materials for use during the response may impact vegetation. The amount of impact would depend on the size and location of the spill, but in most cases would be temporary and plants would recover in one to several years.

Commercial Gas Development

The types of impacts on vegetation that natural gas development and production would cause would be the same as those caused by oil development described above, except that there would be no crude-oil spills and burial of a gas pipeline would destroy or alter additional vegetation. The 162-mile-long buried gas pipeline projected for this alternative would destroy about 80 acres of vegetation directly through excavation of a 4-foot-wide trench and, potentially, alter 210 acres along an approximately 11-foot-wide strip where compaction and other indirect effects from use of machinery and temporary storage of overburden would occur. Because of the width of this disturbed area, colonizing species would not be able to quickly reinvade the disturbed soil, suggesting a recovery time of several years or longer, though wetter areas would generally revegetate before drier areas (McKendrick, 2000). In addition, vegetation would be lost to a 10- to 20-acre compressor station pad. Placement of gas pipelines on VSMs would reduce the amount of destroyed vegetation to that at the base of the VSMs, assuming that a new set of VSMs are necessary rather than place the gas pipeline on an existing oil pipeline system of VSMs. Impacts to vegetation from VSM-mounted pipelines would be limited to shading and any impacts from maintenance (primarily, if not exclusively, in winter) or repair. In addition, ice roads that may be associated with placement of an aboveground or buried gas pipeline would have localized, short-term impacts on vegetation, which would usually be limited to damage to the tops of tussocks in dryer soils.

4.3.5.3 Effectiveness of Stipulations

Lease stipulations described in the 1998 Northeast IAP/EIS ROD should effectively reduce the impacts of development on vegetation under Alternative A. Specific lease stipulations 1-17 on solid and liquid-waste disposal, fuel handling, and spill cleanup would be expected to reduce the potential effects of oils and other waste on vegetation. Lease stipulations 23 and 24a-n on overland moves and seismic work would also effectively minimize impacts to vegetation.

Lease stipulations on activities associated with oil and gas exploration (27 and 28) and development (32, 40, 42, 43, 45 and 46), such as facility design and construction of pipelines, roads, drill pads, airstrips, and other facilities, are expected to effectively minimize the amount of habitat that would be altered by gravel pads and other surface disturbances. The setbacks outlined in lease stipulations (30, 39a-i, 41 and 46) associated with development near rivers and lakes would be effective at minimizing impacts in high value wetlands, such as areas dominated by pendant grass and riparian and floodplain habitats.

4.3.5.4 Conclusion

Under Alternative A, impacts to vegetation from activities other than oil development would include minor impacts to vegetation from aircraft landings, archaeological or paleontological excavations, camps, and overland moves and would affect approximately 165 acres of vegetation. The duration of these impacts would be short term, ranging up to five months, and recovery would vary from one to several years.

Impacts to vegetation from oil and gas exploration would occur from seismic work and construction of well cellars during exploratory drilling and the construction of ice roads and ice pads. The duration and recovery time for impacts associated with seismic work would be similar to those for overland moves. Based on earlier studies, there should be no substantial, long-term impacts to vegetation from seismic lines, but camp move trails could substantially impact approximately 153 acres after 8-9 years. Effects of well cellar construction would also be permanent, but would impact less than 1 acre of vegetation.

The effects of oil and gas development and operation would include destruction of vegetation during construction of gravel pads (CPFs, satellite drill pads, pump stations, and staging bases), roads, and airstrips, from excavation of material sites and burial of gas pipelines, and construction of VSMs. These impacts would be long-term and would impact about 3,270 acres, or 0.07% of the 4.6 million acre planning area. (An additional 80 acres would be destroyed through burial of gas pipelines). Plant communities could also be altered by dust deposition, salinity of gravel fill used in construction, snow drifts, and blockage of or change to natural drainage patterns. These impacts would be also be long-term and would impact about 9,343 acres, or 0.2% of the planning area.

Spills of oil, other chemicals, and saltwater could occur and would have long-term impacts, except for those associated with small-size spills, which would be cleaned up immediately, allowing recovery within a few years to two decades.

Under Alternative A, development would be unlikely to affect plant species or communities. However, if development facilities were constructed in an area containing a population of a rare plant species, the impacts to that species could be severe. Three rare North Slope plant species are known to occur in the planning area, and four other rare species are known to occur on the North Slope but have not been documented in the Northeast NPR-A. Sabine grass is an aquatic

grass that rarely occurs between the pendent grass and sedge zones in lakes and ponds. This species is known from a few locations north and northeast of Teshekpuk Lake, which would be protected from development under Alternative A. Stipulated cinquefoil has been found at Umiat. This Asian species is found in sandy substrates, such as sandy meadows, and riverbank silts and sands other than dunes. This species would be protected by setbacks along rivers in the planning area and by the designation of the Colville River Special Area. Muir's fleabane, Drummond's bluebell, and Hartz's bluegrass all occur in dry habitats associated with bluffs, floodplains, river terraces, sand dunes, rocky outcrops and fellfields. These habitats are the primary sources of gravel fill used during construction and development (NRC 2003) and could be impacted by development in these areas.

Impacts to vegetation from non-oil and gas activities, and from oil and gas activities, would likely be additive, except in those areas where the two types of activities overlapped. Impacts to vegetation from exploration and development activities would also be additive, except where development activities occurred in areas previously disturbed during exploration. In areas where two or more activities occurred, overall impacts would reflect those impacts associated with the first activity and any new impacts associated with later activities. Because of the smaller disturbance area, the potential for impacts to vegetation resources under this alternative would be about 16-28% less for exploration activities, and 9% (Alternative B), 28% (Alternative C) and 25% (Alternative D), less for oil production and development activities, as compared to the action alternatives.

4.3.6 Wetlands and Floodplains

This section discusses the potential effects to wetlands and floodplains that could result from management action in the planning area under Alternative A. The following sections summarize the information previously presented in the 1998 Northeast IAP/EIS (USDOI BLM and MMS 1998), which has been amended with additional data from studies conducted since 1998, particularly for the Northwest IAP/EIS (USDOI BLM and MMS 2003). It has also been updated with a new scenario for "reasonably foreseeable development" of oil and gas resources.

In compliance with Executive Order 11990, Protection of Wetlands and Executive Order 11988, Floodplain Management, the BLM has prepared an impact analysis on those areas within the planning area that are considered to be wetlands or floodplains, as described in **section 3.3.3, *Wetlands and Floodplains***. Approximately 95% of the planning area would be considered wetlands, according to established criteria for determining wetland status. It is likely and therefore assumed that all ground-disturbing actions will be impacting wetlands for the purposes of calculating short and long-term impacts.

Executive Orders

Portions of both executive orders are described below and do not specifically apply to approval of this planning effort. Future development will require NEPA reviews and further evaluation of wetlands and floodplains impacts during the approval and permitting process from BLM and other agencies.

Protection of Wetlands (Executive Order 11990)

Executive Order 11990 concerning the protection of wetlands requires that BLM consider factors relevant to the proposal's effect on the survival and quality of the wetlands. Factors to be

considered include the following: (1) Public health, safety, and welfare; including water supply, quality, recharge and discharge, pollution; flood and storm hazards; and sediment and erosion; (2) Maintenance of natural systems; including conservation and long-term productivity of existing flora and fauna, species and habitat diversity and stability, hydrologic utility, fish, wildlife, timber, and food and fiber resources; and, (3) Other uses of wetlands in the public interest, including recreation, scientific, and cultural uses.

In furtherance of the NEPA of 1969 (42 U.S.C. § 4331(b)(3)) to improve and coordinate Federal plans, functions, programs and resources so that the nation may attain the widest range of beneficial uses of the environment without degradation and risk to health or safety, the agency, to the extent permitted by law, shall avoid undertaking or providing assistance for new construction located in wetland unless the head of the agency finds:

1. There is no practicable alternative to such construction, and
2. The proposed action includes all practicable measures to minimize harm to wetlands which may result from such use. In making this finding the head of the agency may take into account economic, environmental and other pertinent factors.

Floodplain management (Executive Order 11988)

Executive Order 11988 concerning Floodplain Management requires an agency to provide leadership and to take action to minimize the impact of floods on human safety, health, and welfare, and to restore and preserve the natural and beneficial values served by floodplains in carrying out its responsibilities. As required by Executive Order 11988, the agency has a responsibility to:

1. Evaluate the potential effects of any actions that may take place in a floodplain;
2. Ensure that its planning programs and budget requests reflect consideration of flood hazards and floodplain management; and
3. Prescribe procedures to implement the policies and requirements of Executive Order 11988.

Additional requirements are as follows:

1. Before taking an action, each agency shall determine whether the proposed action will occur in a floodplain and the evaluation required will be included in any statement prepared under Section 102(2)(C) of the NEPA (42 U.S.C. § 4332(2)(C)).
2. If an agency has determined to, or proposes to, conduct, support, or allow an action to be located in a floodplain, the agency shall consider alternatives to avoid adverse effects and incompatible development in the floodplains. If the head of the agency finds that the only practicable alternative consistent with the law and with the policy presented in this Order requires siting in a floodplain, the agency shall, prior to taking action: (1) design or modify its action in order to minimize potential harm to or within the floodplain, consistent with regulations, and (2) prepare documentation explaining why the action is proposed to be located in the floodplain.

4.3.6.1 Activities Not Associated With Oil and Gas Exploration and Development

Various types of activities not related to oil and gas leasing and development could affect floodplains and wetlands in the planning area. Off-runway landings by private or commercial wheeled aircraft could cause short-term damage to vegetation present on the landing sites. Most

wheeled aircraft landings would occur on sand or gravel bars on floodplains or possibly on dry gravelly ridges. Therefore, impacts from such landings would likely be minor and sporadic in occurrence.

Archaeological and paleontological digs could impact wetlands and floodplains but would probably be limited to relatively small areas. Depending on the location of the dig, it could be possible to remove sod such that it could be replaced once activities at the site were concluded, resulting in a temporary disturbance. However, many digs would result in the destruction of vegetation at the site. Overall, the extent of these activities would likely impact only a few acres in the planning area, spread out over several locations.

Camps associated with scientific studies, recreational use and other activities could result in trampling of vegetation from foot traffic and tent placement, and in small spills of stove, boat, or generator fuel. These impacts would typically be temporary, lasting from less than one to several growing seasons. Recreational and scientific camps are often located within floodplains on river bars where vegetation cover is low. It is likely that larger camps would be located on existing gravel pads, which mostly lack vegetation. The total land surface impacted by camps is expected to be small (less than 10 acres) and the sites would be scattered. Most traces of summer camps will be removed by floodwaters during breakup the following Spring, particularly within the Arctic Coastal Plain.

The use of OHVs such as four-wheel vehicles and snowmachines could cause localized impacts to wetlands. Snowmachines used during the winter when the ground is frozen with adequate snow cover would have little or no impact to the vegetation. However, heavy use of a trail could cause compaction of vegetation. In addition, heavy use of snowmachines during fall or late spring or in areas without adequate snow cover could result in damage to the vegetative mat which may lead to thermokarst. Similarly, use of four-wheel vehicles and Argos (6-8 wheeled vehicles) on tundra can disrupt the vegetation and churn soil in the upper portion of the profile, leading to thermokarst in wet tundra and damage or death of plants in drier areas. The use of airboats in shallow marsh areas could also impact wetlands, although if confined to the river channel, airboats would have no impact on aquatic vegetation.

Overland moves occurring in the planning area typically involve traffic between Deadhorse and Barrow to resupply villages. These moves may also involve resupply of remote field camps in the NPR-A. Moves would occur during winter when the ground was sufficiently frozen and covered with snow to prevent damage to the underlying tundra. Impacts to wetlands associated with transport vehicles depend on the type of vehicle, the vegetation type, and the snow conditions. In general, low ground-pressure wheeled vehicles have less impact than do tracked vehicles or sleds on skids. In wetter tundra areas, impacts are usually limited to "green" trails caused by compression of snow and dead plant material, where standing dead vegetation has been laid down leaving only newer, greener vegetation standing in the following summer. Such trails are often visible for one to several growing seasons. In general, wet areas may be less affected than dry areas (Walker 1996), and snow acts as a buffer against these impacts. Overall, vehicle tracks may affect vegetation, soil chemistry, soil invertebrates, soil thaw characteristics, and cause small-scale hydrologic changes (Kevan et al. 1995). Avoidance of areas with low snow cover, use of low ground pressure vehicles, dispersed traffic patterns, and minimizing sharp turns could help to minimize damage. However, tracked vehicles can disrupt the vegetation surface when making tight turns or by dropping the vehicle's blade too deeply into the snow. In wet tundra this disruption can result in water accumulation and thermokarst. In drier tundra, travel over low shrubs can cause breakage and tussocks may be broken or crushed. Severity of

impacts would depend upon the actual location and type of habitat, but impacts could range from temporary to long-term.

4.3.6.2 Oil and Gas Exploration and Development Activities

The following analysis is based on **section 4.2.1.2, *Oil and Gas Exploration and Development Activities***. See that section for a description of how estimated areas of disturbance were calculated for each alternative.

Effects of Disturbances

Various activities associated with oil and gas exploration, development and production could impact wetlands and floodplains in the planning area. These activities include seismic operations, exploration drilling, construction of ice roads and ice pads, gravel roads, gravel pads for pump stations, CPFs, and staging bases, airstrip and pipeline construction, remediation efforts, legacy well-plugging activities and gravel mine sites.

Exploration

During oil exploration, various activities could cause impacts to wetlands and floodplains in the planning area. These activities include seismic operations, exploration drilling, and construction of ice roads, pads and airstrips.

Seismic surveys. Seismic surveys to collect geological data would occur during the winter months. Frozen ground and sufficient snow cover (required by Stipulation 24i) would serve to prevent most disturbances to wetland vegetation and floodplains. A majority of seismic surveys create minor, short-term disturbance to wetlands and floodplains. Areas of disturbance could be caused at streambank crossings from damage to the vegetative mat which could be scraped away, leaving exposed soil. Disturbance could also be caused to vegetation on the tops of tussocks in dryer areas. Water saturated areas show less damage to vegetation and soils from large tired vehicles (USDOI 2005). In some instances past overland moves and seismic surveys have disturbed wetlands, altered the thermal balance, and increased the risk of thermokarsting (Jorgenson et al. 1996). Improvements in the equipment and procedures used for seismic surveys have reduced the amount of impact to tundra, resulting in a higher percentage of tundra in categories of minor or little to no impacts and few if any highly-impacted sites. Calculations of areas impacted by seismic operations in this analysis use environmentally conservative numbers, but it should be noted that the projected impacts are probably greater than actual impacts would be.

The following analysis quantifies the potential impact of three anticipated 2-D surveys and two anticipated 3-D surveys. If advances in seismic survey technology make resurveying of already surveyed lands attractive, additional surveying could occur and add an undetermined amount of impacts. Under Alternatives A and D it is unlikely that seismic surveys would occur on Teshekpuk Lake. 2-D surveys are most likely in the foothills area. The length of 2-D surveys would be much shorter than normal, however, and the total length for all surveys would be approximately 250 miles. These surveys could be accomplished in as little as a season or two. The maximum area impacted by 250 miles of seismic lines would be 6,060 acres (Table 4.2-F). Trails also are made by camp-move vehicles, which traverse about the same distance as line miles of 2-D survey as well as traveling to and from the survey area. Assuming that there would be three 2-D surveys that on average would require a roundtrip camp move of 106 miles, camp moves to and from seismic survey areas would potentially impact 1,156 acres. This would

be in addition to 910 acres potentially disturbed by camp train moves along the total 250 miles of anticipated 2-D seismic. Therefore, the total number of acres affected by 2D seismic operations is estimated at 8,126 acres (6,060 + 1,156 + 910). This estimate does not take into account areas affected by receiver lines perpendicular to the main lines or to stray vehicle trails.

3-D seismic surveying would have the potential to cause greater impacts to wetlands than 2-D seismic surveys since tighter turns by heavy equipment are required. It is assumed that each 3-D seismic operation would cover a total area of 600 mi^2 (384,000 acres) involving a grid pattern of source and receiver lines, with source lines being less than 50 feet wide and receiver lines being about 100 feet wide. Approximately 98,880 acres total would be covered by 3D surveys (Table 4.2-F). In addition, it is assumed that camp trains would move approximately 30 miles within the surveyed areas and 106 miles roundtrip to reach the sites amounting to an additional area covered of 990 acres. Therefore, the total number of acres affected by 3D seismic operations is estimated at 99,870 acres (98,880 + 990), (2.2% of the 4.6 million acre planning area). Impacts from overland moves and seismic work are mitigated by Lease Stipulation 22 which prohibits alteration of river banks and clearing of willows and Lease Stipulations 24 (c,d,f,g,h,i,j,l,n) which reduce impacts to wetlands from overland moves and seismic work. See **section 4.3.5.2** under the vegetation section for a more thorough analysis of potential impacts to vegetation and wetlands from seismic surveys.

Ice Pads and Roads. During exploration, the construction of ice pads for drilling exploratory or delineation wells and ice roads used to access the pads would impact wetlands and floodplains in the planning area. In general, construction of ice roads and ice pads would have only localized impacts on vegetation, usually limited in wetter areas to compression of the tundra vegetation under the roads and pads and a shortened growing season for the plants in the following summer due to delayed melting of the ice in the spring. However, ice roads and pads could also cause breakage of shrubs and scuffing and crushing of tussocks in moist or drier habitats, and localized areas of plant death (Jorgenson 1999; Pullman et al. 2005; Yokel et al. in press). Recovery from most impacts to vegetation would be expected within a few years. Under Alternative A it is assumed there would be a total of 151 ice pads built for exploration and delineation wells, impacting 906 acres on a short-term basis.

Ice-road construction could induce changes in water chemistry of water along the roadbed during and after meltout. The water withdrawn from lakes to construct the roadway would be more saline than typical snowmelt waters. In addition, the salts frozen into the ice road would leach out of the ice prior to its melting during snowmelt, increasing the initial salt content of the meltwater. This effect could be measurable during initial snowmelt, but the effect on water quality and local vegetation should be minimal and localized. For Alternative A, it is estimated that a total of about 5,200 miles of ice road would be constructed during the life of the plan impacting approximately 15,642 acres on a short-term basis, assuming a 25 foot width (Table 4.2-G). This also represents the total short-term disturbance from ice roads. It is assumed that long-term disturbance from ice roads would be negligible.

Multi-year ice pads allow use of the pad in a second winter, but require insulation of the ice pad to prevent melting during the spring and summer. Studies of vegetation recovery at an extended year ice pad found the vascular plant cover was still 34% lower than pre-pad cover two years after the pad melted (Noel and Pollard 1996). Additionally, some melting often occurs around the perimeter of the pad, causing vegetation at the perimeter to break dormancy. If plants breaking dormancy are covered by the insulating layer or by timbers or other material used to hold the cover in place, they die from the lack of sunlight (Hazen 1997, McKendrick 2000). In the past eight years of exploratory drilling in the NPR-A, 25 wells have been drilled

and one over-summer ice pad has been used for rig storage. If future work follows the same percent, then 151 wells could result in the use of 6 over summer pads, affecting 36 acres of tundra.

Ice airstrips are also used during exploratory drilling, and under Alternative A, it is assumed that up to 20 ice airstrips would be constructed covering 11 acres each for a total of 220 acres. These airstrips are commonly built on the grounded ice of large lakes, but if they were built over tundra they would result in impacts similar to ice roads.

Ice and snow bridges cross streams and must be designed with a gradual slope and sufficient thickness to allow rig moves and other heavy machinery to cross drainages without damaging shrubs and streambanks. These ice and snow bridges have the potential to impound flowing water during breakup and to cause localized scour and downstream deposition if these bridges are not breached. Lease Stipulations 22, 24c, and 24d prescribe protection of streambanks, crossing at low angles, and breaching of snow bridges to maintain natural conditions of the floodplain and stream channel while prohibiting high-angle crossings.

The construction of well cellars during exploration requires the digging of a hole that destroys vegetation on approximately 16 square feet (0.00037 acres) of ground, replacing that vegetation with bare soils. Thermokarst associated with the disruption of the thermal regime in the surrounding soil may also change the vegetation type around the well cellar to a wetter vegetation type. These impacts could result in 0.06 acres of vegetation being destroyed under Alternative A, assuming construction of 151 well cellars.

Development and Production

During oil development and production, various activities could cause impacts to wetlands in the planning area. These activities include construction of gravel pads for pump stations, staging bases and CPFs, roads, airstrips, pipelines, excavation of material sites, and construction of ice roads. Impacts of ice roads were discussed previously under the "Exploration" subheading.

Placement of Gravel Fill. Construction of CPFs and associated satellite pads, roads, pump station, staging bases, and airstrips would result in the loss of wetlands in areas where gravel was placed. Development of this infrastructure under this alternative would result in a total of 2,718 acres of wetlands lost by gravel placement.

Construction of gravel pads, roads, and airstrips could alter the moisture regime of tundra near the structure by changing natural drainage patterns and areas where snow accumulates. Snowdrifts caused by gravel structures increase the wintertime soil surface temperature and increase thaw depth in soils near the structures. These impacts are exacerbated by dust deposition and by the formation of impoundments. These factors could combine to warm the soil, deepen thaw, and produce thermokarst adjacent to roads and other gravel structures (NRC 2003). Additionally, these changes could alter the species composition of the plant community near gravel structures. In general, most changes in the plant community around gravel structures would occur within 164 feet of the structure (Woodward-Clyde Consultants 1983).

The passage of vehicle traffic over gravel pads and roads would result in dust and gravel being sprayed over vegetation within about 30 feet of the pad or road, and a noticeable dust shadow out to 150 feet or more. Within 30 feet of gravel structures, the dust and gravel could smother vegetation. The effects of dust on vegetation include early snowmelt, reduced soil nutrient

concentrations, lower moisture, an altered soil organic horizon, and higher bulk density and depth of thaw (Everett 1980; Walker and Everett 1987; Auerbach et al. 1997). These studies found that plant species richness was reduced near gravel structures, particularly in naturally acidic soils. A decrease in acidophilus mosses, some lichen species, and certain heath taxa altered species composition (Walker and Everett 1987). In areas that experience heavy dust fallout, native plant communities could be killed and replaced by early-successional colonizers and species more tolerant of the altered site conditions, including possibly non-native, invasive species. The magnitude of these effects would depend on the duration of dust exposure (i.e., traffic intensity) and the distance from the source. Traffic volume and speed would generally be minor on in-field roads in the planning area, which would limit dust impacts to vegetation.

Alternative A assumes a total of 230 miles of in-field gravel roads and 5 miles of airstrips with a potential for a total perimeter of 470 miles. Within 30 feet of gravel fill, up to 1,709 acres of vegetation could be subject to smothering by dust and gravel, and between 30 and 150 feet, another 6,836 acres, for a total of 8,545 acres affected by a dust shadow of 150 feet. If all effects were considered to occur within a 164 foot zone, a total of 9,343 acres would be affected.

The material used for gravel fill could also impact vegetation near gravel structures. Saline material used as fill increases the salinity of water draining off of or leaching through the structure. Increased salinity at a site could alter the species composition of the plant community in the immediate vicinity of the gravel structure, shifting the community toward one comprised of species that are more tolerant of saline conditions (McKendrick 2000).

Blockage of natural drainage patterns can lead to the formation of impoundments. Impoundments, which would generally be confined to areas of wet and aquatic vegetation, could alter both the hydrology and species composition of wetlands. Plant productivity could increase biomass of a few species; or productivity may decrease, as a result of loss of plant communities to the development of deep, open water areas. In most cases, impoundments would lead to a decrease in plant species richness (Klinger et al. 1983; Walker et al. 1987a, b). The use of adequate cross drainage structures in gravel roads and attention to the natural drainage patterns during design of developments could help reduce impacts to vegetation from impoundments. Lease Stipulation 42 prescribes proper drainage structures such as bridges instead of culverts over major river crossings to prevent erosion and ice-jam flooding, Lease Stipulation 43 requires road and pipeline crossings to be designed to limit erosion from flooding and wave action and cross-drainage structures maintained to prevent impoundments.

Stream Crossings. Rivers and creeks could be affected from construction of bridges, culverts, and pipelines crossing drainages. These structures can block, divert, impede, or constrict flows. Blockage or diversions to areas with insufficient flow capacity can result in seasonal or permanent impoundments. Constricting flows can result in increased stream velocities and a higher potential for ice jams, ice impacts, scour, and streambank erosion. Impeding flows can result in a higher potential for bank overflows and floodplain inundation. Lease Stipulations 42, 43, and 44 provide guidance on the use of bridges and culverts and best management practices to ensure that the natural drainage pattern would be maintained.

Material Sites. Much of the gravel used for construction of roads, pads, and airstrips on the North Slope in the past has been obtained from deposits in river floodplains. Impacts from these activities include habitat modifications, caused by increased braiding and spreading of flows (Woodward-Clyde Consultants 1980, NRC 2003). Established guidelines have largely restricted gravel mining to deep mining in upland pits, which can be flooded on abandonment to create aquatic habitat, including fish overwintering areas (NRC 2003). Gravel required for

development in the planning area could be mined from existing sites east of the NPR-A, or could be extracted from new sites developed within the planning area. Investigations to identify gravel sources in the NPR-A have not been conducted, but presumably would be initiated if discoveries of recoverable oil and gas were made. Under Alternative A it is assumed that 11 material sites, each affecting 50 acres, would be needed. This would cover a total area of 550 acres. Excavation of the gravel mine and stockpiling of overburden would destroy wetlands at gravel extraction sites.

Pipelines. Pipelines on the North Slope are typically built on VSMs with a diameter of 12 inches and a spacing of 150 VSMs/mile for in-field gathering lines and 81 VSMs/mile for sales pipelines. In addition to the vegetation displaced by the VSM, installation of VSMs disturbs a zone around the VSM that is approximately 20 inches wide. This zone of disturbance results from spoil material deposited around the VSMs and from thermokarst, which may result in a change in species composition around the VSMs. Approximately 0.03 acres of vegetation would be disturbed per pipeline mile. Under Alternative A, 230 miles of gathering lines and 162 miles of sales-oil pipelines would disturb 12 acres of vegetation through VSM placement.

Pipelines could also impact wetlands indirectly by altering snow accumulation patterns and by shading vegetation. In general, the snow pack was most likely to be deeper under pipelines with an east-west orientation, and when pipeline clearance was reduced to below 5 feet. Vegetation under a pipeline receives less direct sunlight during the growing season than does vegetation that is not under a pipeline. Therefore, there could potentially be a decrease of photosynthesis in plants growing under pipelines, and a reduction in heat absorption by the ground cover, leading to a shallower active layer.

In areas where pipelines were buried, impacts to wetlands would be different. Pipeline burial would destroy vegetation where the trench was constructed and would alter vegetation in adjacent areas where temporary storage of the overburden occurred. The zone of impact would be approximately 12 feet wide for the length of the buried segment, and would impact 1.5 acres per pipeline mile. "Hot oil" pipeline burial under tundra has been the exception on the North Slope rather than the norm, and this document does not assume any burial. Gas pipelines can be buried, but this scenario does not assume development of gas within the life of this plan. Thus pipeline burial is unlikely, but if required to mitigate other surface impacts vegetation would be affected as described here.

Effects of Spills. Spills could impact wetlands and floodplains in the planning area. Spills may consist of refined or crude oil as well as saltwater. See **section 4.2.2, *Oil Spills*** for a more extensive discussion of the fate and behavior of spills, and for an estimate of potential future oil spills by alternative.

Spills of refined oil could occur during overland moves, seismic surveys, from a large storage tank, pipelines, or from oil spill response training and cleanup. Typical refined products that are spilled on the Alaska North Slope include aviation fuel, diesel fuel, engine lube oil, fuel oil, gasoline, grease, hydraulic oil, transformer oil, and transmission oil. These spills would likely be small, averaging 3 to 5 gallons or less, and would affect small areas (less than 50 square feet). Contaminated snow would be cleaned up immediately upon discovery. A spill from a large storage tank, which would be much less likely, could impact up to 500 square feet. Overall, past spills of this size and type on Alaska's North Slope have caused minor ecological damage and ecosystems have generally recovered, with wetter areas recovering more quickly than drier areas (Jorgenson 1997, McKendrick 2000).

The extent of environmental impacts of a spill would depend upon the type and amount of materials spilled, the location of the spill, and effectiveness of the response. The majority of small spills would be contained on the gravel pad and would have no impact on vegetation. Approximately 20 to 35% of past crude oil spills have reached areas beyond pads. For this analysis, it was assumed that 27% of all spills would occur or reach beyond gravel pads. Most spills would happen during the winter and could be cleaned with minimal impacts to wetlands. If it is assumed that 40% of all spills would occur during the summer, approximately 11% of all oil spills would reach vegetation and have more than a negligible effect. Under Alternative A this would mean 197 of the 1,792 crude and refined oil spills assumed to occur over the life of the plan would reach vegetation.

Most oil spills would cover less than 500 square feet (<0.01 acres). However, a spill event that includes an aerial pressured discharge can cover substantially more area as documented at an ARCO drill site in 1993 when 1-4 bbl of crude oil misted over an estimated 145 acres (Ott 1997). (Such a spill is a very low probability event, occurring less than once out of the total spills expected throughout the life of this Plan. Thus its magnitude is not apparent in the following acreages.) Assuming the average spill would cover 0.1 acre, under Alternative A, approximately 20 acres would be impacted substantially during the lifetime of development in the planning area.

Oil spills on wet tundra kill the moss layers and aboveground parts of vascular plants, and sometimes kill all macroflora at the site (McKendrick and Mitchell 1978). Damage to oil-sensitive mosses could persist for several years if the site were not rehabilitated. The length of time a spill would persist would be dependent upon soil moisture and the concentration of the product spilled. McKendrick (2000) reported that complete vegetation recovery occurred within 20 years on a wet sedge meadow without any cleanup. A dry habitat exposed to the same application supported less than 5% vegetative cover after 24 years. Overall, past spills on Alaska's North Slope have resulted in minor ecological damage and ecosystems have shown good potential for recovery because most of the habitat is wet (Jorgenson 1997).

If seawater were used for enhancement of oil production, a saltwater spill could occur within the planning area. According to McKendrick (2000), brine spills kill plants on contact and increase soil salinity to the point that many species cannot survive. Unlike oil, salts are not biodegradable, and natural recovery occurs only after salts have leached from the soil. A saltwater spill would have effects on salt-intolerant vegetation near the seawater pipeline, but the amount of tundra habitat affected would be limited to a few acres or less. In the case of a saltwater spill on tundra, the water would likely be adsorbed into the vegetative mat or, in wet habitats, diluted with fresh water.

Oil spill response training and cleanup may also impact wetlands and floodplains. Trampling of vegetation and stockpiling of materials for use during the response may impact wetlands. The amount of impact would depend on the size and location of the spill, but in most cases would be temporary and plants would recover in one to several years. Lease Stipulations 7- 16 address spill notification, cleanup requirements, plans, materials, training and spill response, storage, and refueling.

Summer Tundra Travel. Summer tundra travel would not be permitted under Alternative A. Therefore, no impacts to wetlands or floodplains in the planning area would be expected.

Abandonment and Rehabilitation

During abandonment activities, wetlands and floodplains would be impacted by dust fallout along roads, by ice roads and other off-road tundra travel associated with dismantling of pipelines and power lines, and by disturbance to vegetation adjacent to VSMs and power line poles during their removal. The level of impact from these activities would be roughly the same as that during construction if gravel fill was removed; impacts would be less if the gravel were to be left in place. If roads and pads were left in place, and especially if cross drainage across roads was not maintained, water impoundment would occur, and could alter plant communities as described for the construction period. It is also likely that the non-maintained roads would have occasional washouts, where tundra vegetation would be covered with washed-out gravel. Roads and pads, if left in place, would likely need to be revegetated with plants native to gravel bars and ridges in the Arctic (i.e., different from the plant communities surrounding the facilities). Revegetation activities could take several years, as initial attempts are not always successful. Removal of gravel from pads, roads, and airstrips could be mandated. Partial or complete removal of gravel can result in faster reestablishment of native plant growth, although establishment can take many years (more than a decade). In addition, thaw subsidence is difficult to predict, and complete restoration to preexisting conditions is not likely. Lease Stipulation 58 would provide for removal of all oil and gas facilities at the time of field abandonment to the satisfaction of the AO.

Commercial Gas Development

Development of commercial gas in the planning area would reflect the impacts described for soils, water, and vegetation. The types of impacts from natural gas development would be the same as those caused by oil development, except that there would be no crude-oil spills, 10 to 20 acres would be covered with a gravel pad for a compressor station, and, if a gas pipeline is buried, additional acreage would disturbed with increased potential impacts on wetlands and floodplains. The 162-mile-long buried gas pipeline projected for this alternative would disrupt about 80 acres of wetlands directly through excavation of a 4-foot-wide trench and, potentially, alter 210 acres along an approximately 11-foot-wide strip where compaction and other indirect effects from use of machinery and temporary storage of overburden would occur. Because of the width of this disturbed area, colonizing vegetation would not be able to quickly reinvade the disturbed soil, suggesting a recovery time of several years or longer, though wetter areas would generally revegetate before drier areas (McKendrick, 2000). Placement of gas pipelines on VSMs, would reduce the amount of destroyed soils and vegetation to that at the base of the VSMs, assuming that a new set of VSMs are necessary rather than place the gas pipeline on an existing oil pipeline system of VSMs and would lessen the impacts on natural waterflow. Impacts to vegetation from VSM-mounted pipelines would be limited to shading and any impacts from maintenance (primarily, if not exclusively, in winter) or repair. In addition, ice roads that may be associated with placement of the gas pipeline would have localized, short-term impacts on vegetation, which would usually be limited to damage to the tops of tussocks in dryer soils, and in the spring when the ice roads melted may add somewhat saline water to a shallow tundra pools.

4.3.6.3 Effectiveness of Stipulations

Lease stipulations described in the 1998 Northeast IAP/EIS ROD should effectively reduce the impacts of development on wetlands and floodplains under Alternative A. Many of the lease stipulations under Alternative A directly or indirectly limit potential impacts to wetlands and floodplains in the planning area. Applicable stipulations are listed in the following paragraphs.

Lease Stipulations 1 through 16, and 24(m, n) relate to waste prevention, handling, disposal, spills, and public safety. These lease stipulations would ensure that waste materials associated with exploration and development activities were properly disposed of, and help prevent impacts to wetlands and floodplains from spills and mishandling of materials. They would also provide for rapid cleanup of spills, which would decrease the likelihood of impacts to vegetation.

Lease Stipulations 18 and 22 relate to ice roads and water use; Lease Stipulation 18 requires the offsetting of ice roads, and Lease Stipulation 22 prohibits alteration of river banks and clearing of willows.

Lease Stipulation 24 relates to overland moves and seismic work; Lease Stipulation 24c requires low-angle crossings at waterways, Lease Stipulation 24d requires snow bridges to be clean of soil and to be removed before breakup, Lease Stipulation 24f requires use of low-ground-pressure vehicles, Lease Stipulation 24g prohibits bulldozing of trails, Lease Stipulation 24h prohibits using the same trails for multiple winter trips, Lease Stipulation 24i requires 12 inches of freezedown and 6 inches of snow cover before ground operations commence, Lease Stipulation 24j requires cessation of ground operations when spring melt begins, Lease Stipulation 24L prohibits tracked vehicles from turning by locking one track, and Lease Stipulation 24n prohibits refueling of equipment within the active floodplain.

Lease Stipulations 27 and 28 apply to oil and gas exploratory drilling; Lease Stipulation 27 would minimize surface impacts from exploratory drilling by limiting activities to temporary structures such as ice pads, ice roads, ice airstrips and temporary platforms, unless permanent structures were absolutely required, and Lease Stipulation 28 prohibits exploratory drilling in river, stream or lake beds.

Lease Stipulations 30-32,38-43,46 apply to facility design and construction; Lease Stipulation 30 prohibits causeways and docks within river mouths or deltas. Lease Stipulation 31 prohibits oil and gas facilities within the Teshekpuk Lake Surface Protection Area. Lease Stipulation 32 provides facility design and construction regulations that would limit the footprint of developments, Lease Stipulation 38 requires all pipelines to use the best available technology for detecting corrosion during inspections, Lease Stipulation 39 requires setbacks from major rivers of ½ mile to 3 miles for oil and gas facilities. Lease Stipulation 40 places restrictions on the development of gravel mining sites. Lease Stipulation 41 prohibits permanent oil and gas structures from within 500 feet of waterbodies, Lease Stipulation 42 prescribes bridges instead of culverts over major river crossings to prevent erosion and ice-jam flooding, Lease Stipulation 43 requires road and pipeline crossings to be designed to limit erosion from flooding and wave action and cross-drainage structures maintained to prevent impoundments, and Lease Stipulation 46 minimizes development within key wetlands important to fish, waterfowl, and shorebirds.

Lease Stipulations 58,63,67,70 and 78 apply to oil field abandonment, orientation programs, and other activities; Lease Stipulation 58 would provide for removal of all oil and gas facilities at the time of field abandonment. Lease Stipulation 63 would help to minimize resource conflicts by providing appropriate orientation programs and training for facilities workers on environmental, social, and cultural concerns. Lease Stipulation 67 would minimize impacts to vegetation and soil resources. Lease Stipulation 70 prohibits construction camps from siting on lakes and rivers, and prohibits bulldozing while leveling trailers on river and gravel bars, and Lease Stipulation 78 prohibits permanent structures from within 100 feet of the nearest body of water.

4.3.6.4 Conclusion

Approximately 95% of the planning area would be considered wetlands, according to established criteria for determining wetland status. In general, the northern portion of the planning area surrounding and north of Teshekpuk Lake has the greatest percentage of wetlands and is thought to be the area with the greatest oil and gas potential. This area would be closed to leasing under Alternative A. Numerous technological advancements have been made during the decades of operations on the North Slope that have allowed current development activities to proceed with less environmental impact than previous operations (NRC 2003). However, some short-term disturbance and permanent long-term impacts to soils are inevitable. Soil stability depends on vegetative cover; where vegetation is disturbed, impacts on soil follow.

Under Alternative A, impacts from activities other than oil development would include minor impacts to wetlands and floodplains from aircraft landings, archaeological or paleontological excavations, camps, overland moves, OHV, snowmachine, four-wheel vehicles, and Argos-type vehicles. Duration of these impacts would be short term, ranging up to five months, and recovery would vary from one to several years.

Impacts to wetlands and floodplains from oil and gas exploration would occur from seismic work, construction of well cellars during exploratory drilling, and the construction of ice roads, pads and airstrips. The duration and recovery time for impacts associated with seismic work would be similar to those for overland moves. Based on earlier studies Jorgenson, there should be no substantial, long-term impacts to wetlands from seismic lines, but camp move trails could substantially impact approximately 153 acres after 8-9 years. Effects of well cellar construction would also be permanent, but would impact less than 1 acre of wetlands.

Short-term impacts could occur on approximately 8,100 acres of wetlands and floodplains from 2-D seismic surveys and 100,000 acres of wetlands and floodplains from 3-D surveys during a 25-year period (Table 4.2-F). Approximately 1,200 acres could be impacted short-term by pipeline construction. Short-term impacts would also occur from temporary ice road, pads, and airstrips. A total of about 5,200 miles of ice road would be constructed during the life of the plan impacting 15,642 acres (Table 4.2-G). A total of 86 exploration wells could be drilled from 6 acre ice pads, totaling 516 acres. Approximately 20 miles of ice runway would be constructed impacting approximately 220 acres.

The effects of oil development and operation would include destruction of wetlands during construction of gravel pads, roads, and airstrips, from excavation of material sites, and construction of VSMs. These impacts would be long-term and would impact about (2,718 + 550 + 12) or 3280 acres of the planning area. Plant communities could also be altered by dust deposition, salinity of gravel fill used in construction, snow drifts, and blockage of or change to natural drainage patterns. These impacts would be also be long-term and would impact about 9,343 acres, or 0.2% of the planning area. In terms of scale, the overall impact to wetlands in the planning area would be minor.

Spills of oil, other chemicals, and saltwater could occur and would have long-term impacts, except for those associated with small-size spills, which would be cleaned up immediately, allowing recovery within a few years to two decades. Under Alternative A, impacts to wetlands and floodplains would be less than impacts estimated for the other alternatives

Impacts to wetlands from non-oil and gas activities, and from oil and gas activities, would likely be additive, except in those areas where the two types of activities overlapped. Impacts to wetlands from exploration and development activities would also be additive, except where development activities occurred in areas previously disturbed during exploration. In areas where two or more activities occurred, overall impacts would reflect those impacts associated with the first activity and any new impacts associated with later activities.

4.3.7 Fish

4.3.7-a Freshwater and Anadromous/Amphidromous Fish

4.3.7-a.1 Activities Not Associated With Oil and Gas Exploration and Development

Ground camps associated with non-oil and gas activities include small groups of people involved in scientific research or recreation. These camps range in size from small mobile parties that remain at a site for a few days to larger camps that are set up for long portions of the summer field season. Small mobile camps, which could be located throughout the planning area, would likely have only small quantities of stove fuel or gas for boat motors. Larger camps or camps located at established sites like the Inigok and Ivotuk airstrips or the Lonely DEW-Line site could store fuel in drums or in large bladders of up to 5,000 gallons. Large camps with caches of jet fuel in excess of 50 gallons would be required to store the fuel in containment dikes equipped with clean-up materials.

Recreational hunting and fishing activities occur primarily along the Colville River under a BLM permit. Float trips from the headwaters down to Umiat are permitted in August and September. A limited number of permits would allow float planes access to lakes within the planning area. Most camp or travel spills should be small (less than five gallons), and would most likely occur during fuel transfers. For the reasons described in the "Effects of Spills" section below, impacts of fuel spills under Alternative A are expected to be minor and have a minor effect on fish populations within the planning area.

Overfishing in commercial or subsistence activities is frequently a concern in Alaska. No data or observations suggest that this is occurring to any degree in the planning area. The small commercial fishery in the Colville River Delta typically operates at relatively nominal harvest levels. Despite the long history of the Arctic cisco subsistence fishery conducted by Nuiqsut residents in the fall, harvest rates from 2004 to 2006 were some of the highest observed during the twenty years of monitoring (MJM Research 2005f, 2006a; personal communication with Larry Moulton, 2007). Similarly, broad whitefish continue to be harvested at substantial levels year after year in the Teshekpuk Lake region. Extensive annual movements and dispersion into multiple habitat types likely contributes to this species' capacity to endure high harvest levels (Morris et al. 2006). Future commercial and subsistence fishing efforts are not projected to increase significantly under Alternative A and are not expected to affect fish populations.

4.3.7-a.2 Oil and Gas Exploration and Development Activities

The following discussion addresses the potential impacts of oil and gas activities on freshwater, anadromous, and amphidromous fish and fish habitat found within and adjacent to the

planning area under Alternative A. These habitat areas include streams, rivers, lakes, and the coastal zone.

Effects of Disturbances

Effects from Seismic Surveys. Seismic surveys use acoustical energy pulses to locate subsurface geological formations that might contain oil or gas. The energy pulses are generated by vibrator equipment mounted on trailers and towed on sleds. Surveys would be conducted during the winter (early December through mid-May) when the frozen snow-covered tundra would allow for extensive vehicle access to different locations within the planning area. Seismic crews would operate from mobile camps that form multi-vehicle "cat trains" of trailer sleds pulled by tractors. Individual surveys would typically last about 100 days and cover survey areas of up to 600 mi^2. Because seismic surveys would be conducted in winter, concerns for overwintering fish in the planning area would include 1) physical damage or acute mortality from acoustic energy pulses; 2) stress associated with acoustic energy pulses; and 3) physical damage to overwintering habitat caused by seismic vehicles.

Research has demonstrated that high-intensity noise can lead to damaged auditory sensory hair cells in fish, effectively reducing the ability to hear (McCauley et al. 2003; Popper 2003; Smith et al. 2004; Popper et al. 2005). The extent of damage and the ability to regenerate these cells is related to the intensity and duration of noise and the species of fish. Underwater shock waves can also cause injury to the swim bladder and other organs and tissue (Wright 1982). However, much of the research related to the impacts of noise on fish has been conducted using airgun arrays, explosives, or long-term background noise (Popper et al. 2004). Very little information exists regarding the impacts of Vibroseis on fish. Due to the lack of available data regarding Vibroseis noise and fish, the Alaska Department of Natural Resources, Office of Habitat Management and Permitting (OHMP), in consultation with the Bureau of Land Management, North Slope Borough, community members from Barrow and Nuiqsut, and WesternGeco, conducted a study to address these concerns (Morris and Winters 2005). This study found no indication of damage to swim bladders, muscle tissue, or blood vessels, and observed eye injuries were likely from running into the side of the holding cage during a flight response. Hearing organs were not examined and will require further investigation. No mortalities were observed. Acute mortality from acoustic energy may be a problem primarily associated with explosive-based sources (Wright 1982; Cott et al. 2003), a method that has not been used in recent years in the Alaskan Arctic.

Fish demonstrated a fleeing behavior in response to vibroseis during the ADNR/BLM 2003 study (Morris and Winters 2005). This is a well-documented response by fish to anthropogenic sounds (Popper et al. 2004; Popper 2003). Because exploration using vibroseis occurs in the winter when physiological stress is the greatest for most fish species, a flight response to underwater sound could be potentially detrimental. Nevertheless, fish wintering in a river or small lake would probably only be exposed to vibroseis noise once as the seismic train traveled overhead. In this scenario, it is not likely that the response to a single sound event would cause eventual mortality. However, the magnitude and intensity of the response observed in the 2003 study (Morris and Winters 2005) indicates that multiple exposures to vibroseis noise during a winter season merits concern. This could possibly occur over larger bodies of water where multiple shots may be required. Given that overwintering habitat represents only about 5% of the planning area, it is unlikely that seismic transmissions would occur directly over overwintering sites with any degree of regularity. Overall, any affects to overwintering fish caused by winter seismic surveys would be localized and would not be likely to have any measurable effect on fish populations within the planning area.

With surveys commencing no earlier than December, ice and snow cover should be sufficient, in most cases, to prevent physical damage and disruption to overwintering pools from vehicle traffic. Lease Stipulation 24(i) states that operations may begin only after the seasonal frost in the tundra and underlying soil reaches a depth of 12 inches and average snow cover is 6 inches. The exact start date would be determined by the AO. Lease Stipulation 24(j) requires that operations cease with the beginning of the spring melt, the exact date of which would be determined by the AO. Lease Stipulation 24(f) requires that all activities be conducted with low-ground-pressure vehicles. While these lease stipulations were designed to protect the underlying tundra and vegetation, they would also offer some protection to fish overwintering pools.

Other restrictions that are specifically designed to protect fish habitat during winter operations include Lease Stipulation 24(e), which mandates that waterways be crossed at shallow riffles when possible to avoid additional freeze-down of deep water pools harboring overwintering fish. Lease Stipulation 24(c) encourages that operators crossing waterways travel a minimum of 100 feet from overwintering streams and lakes.

Overall, it is not expected that seismic activity disturbances occurring during winter under Alternative A would have a measurable effect on freshwater, anadromous, or amphidromous fish populations within and adjacent to the planning area.

Effects from Seismic Surveys in Teshekpuk Lake. Seismic surveys utilizing vibrator equipment (Vibroseis) would be conducted in winter, and potential threats to overwintering fish in Teshekpuk Lake would stem primarily from stress associated with the acoustic energy pulses transmitted into the water column directly over schools of fish. As described above, the multiple shots required to conduct exploration using vibroseis over a large waterbody such as Teshekpuk Lake could be detrimental to fish. If individual fish are exposed to vibroseis noise multiple times, the flight response in fish could possibly deplete energy reserves enough to contribute to eventual mortality. Overall, any affects to overwintering fish caused by seismic surveys on the lake during winter would be localized and likely have no measurable effect on fish populations in Teshekpuk Lake or within the planning area.

Under Alternative A, seismic surveys utilizing airgun arrays would also be allowed on Teshekpuk Lake during the open water period in the summer. Typically, an airgun array is towed behind a boat at a depth of about 12 feet. Shots are typically fired every 50 to 150 feet, or about once every 10 seconds. Because the array is configured to focus sound toward the bottom, effective source levels for sound propagation in the horizontal direction are lower than those below the array. In water, injury and death of organisms exposed to seismic energy depends on two features of the sound source: 1) an extremely high, received peak pressure, and 2) a relatively short time for the pressure to rise and decay (Wardle et al. 2000). Considering the peak pressure and rise/decay time characteristics of seismic airgun arrays used today, the zone in which fish and invertebrates would be harmed should be within a few feet of the seismic source.

As described above, the potential impacts of airgun arrays on fish include stress from fleeing behavior and physical damage or death. Although energy reserves are greater for fish in summer than in winter and eventual mortality from energy expenditure is less likely, numerous exposures to a sound disturbance could divert time away from other important behaviors such as feeding or predator avoidance. However, in cases where habituation has been studied, normal behavior is resumed soon after passage of the array (Chapman and Hawkins 1969). Airgun-caused damage to auditory sensory cells in fish is documented (McCauley et al. 2003)

and may be the greatest concern regarding the use of this technology. A few studies have looked at mortality from seismic pulses on various life stages of fish (reviewed by Turnpenny and Nedwell 1994). In general, the studies indicate that fish eggs and larvae would suffer mortality at zero-peak noise levels of 220 dB. These levels occur only at distances of up to 4 to 10 feet from airguns used during seismic exploration, and some mortality of eggs, larvae, or juveniles could occur up to about 18 feet below large sub-arrays. Adult fish only suffer mortality at received levels of 240 dB, which occur at distances of less than three feet from an airgun. Since it is likely that fish move to avoid the passage of the seismic boat, it is probable that few fish would occur close enough to an airgun to be killed (Davis and Thomson 1999), although eggs would still be vulnerable.

There is evidence that the use of seismic airguns can lead to lower catch rates of fish in a localized area, at least for several days (Engas et al. 1996; Engas and Lokkeborg 2002). Noise from boats conducting seismic surveys could also potentially push fish to different locations within Teshekpuk Lake. There could be a short-term impact on the ability to catch fish that would negatively affect subsistence fishing in Teshekpuk Lake.

Effects from Water Demand. Construction-related activities with the potential to affect Arctic fish include water withdrawal for construction of drill pads, roads, and airstrips, and exploratory drilling. Water is required for drilling operations, camp use, and the construction of ice roads and pads. Up to 1.5 million gallons of water are required to construct a single mile of ice road, and construction of an average 6-acre ice pad requires approximately 500,000 gallons of water. A 10,000-foot exploratory well might require 850,000 gallons of water for drilling. The high water demand associated with these activities would require the tapping of lakes within the planning area. Substantial water demand during winter could affect the overwintering habitats of freshwater and amphidromous fishes.

Most freshwater bodies less than six feet in depth typically freeze to the bottom. It has been estimated that by late winter ice cover can decrease available freshwater habitat in North Slope rivers and streams by approximately 97% (Craig 1989a). Overwintering areas are therefore limited to deep-water pools and channels in rivers and streams, and to lakes deep enough to provide sufficient under-ice free water during winter. In standing waters, 7 feet is considered the minimum depth for supporting overwintering fish (PAI 2002). Moving waters may deter the thickening of ice, thereby providing overwintering habitat at shallower depths; areas within the Colville Delta may adequately overwinter fish at depths of 5 feet. The amount of overwintering habitat also varies with the severity of winter conditions. Colder temperatures and a lack of snow cause increased ice formation, which further reduces the amount of under-ice-free water. Overcrowding can increase stress, deplete oxygen supplies, and increase the concentration of metabolic byproducts to a point that may be fatal to the fish (Schmidt et al. 1989). The limited amount of available overwintering habitat may be the single most important factor affecting fish population size and cyclical fluctuations in abundance (Craig 1989a, Reynolds 1997). Competition for limited overwintering space has been suggested as a major cause of population fluctuations in North Slope broad whitefish stocks (Gallaway et al. 1997). Because of the importance of limited overwintering area to Arctic fish, lease stipulations for Alternative A specifically regulate the winter withdrawal of water from lakes, rivers, and streams.

Lease Stipulation 20 prohibits the withdrawal of water from rivers and streams during winter. Withdrawal would also be prohibited in lakes less than 7 feet deep if those water bodies were connected to, or seasonally flooded by, fish-bearing streams or rivers. Winter water withdrawal from lakes greater or equal to 7 feet deep would be limited to 15% of the estimated under-ice free water. Unlimited winter water withdrawal would be permitted for any lake, at the

discretion of the AO, if it could be demonstrated that the lake contained no fish. State of Alaska fish habitat permits for water withdrawals require approved screens on intake structures in fish-bearing waters. Further protection of fish overwintering sites would be provided by Lease Stipulation 19, which prohibits the compaction or removal of snow from fish-bearing water bodies except at approved areas. Such actions could alter ice thickness in fish-bearing water bodies.

Because little science existed several years ago to guide decisions regarding the appropriate quantities of water to allow for winter water withdrawal from lakes, a number of investigations in Arctic Alaska and Canada were initiated to examine water levels and water chemistry in relation to pumping activities. Lake water level is relevant to fish because it can affect total winter habitat space, summer accessibility, and habitat characteristics (such as littoral zone size), resulting in reduced survival (Heman et al. 1969; Gaboury and Patalas 1984). In the existing area of oil exploration and development in the vicinity of the Northeast Planning Area, pumped lakes have recharged in the spring at levels similar to unpumped lakes (Streever et al. 2001; URS 2001; Baker 2002). These observations are likely transferable to other areas that have a high concentration of lakes; however, areas with sparse lakes will have different watershed dynamics that will require additional study.

The most critical water chemistry parameter for fish in winter is dissolved oxygen. There is some indication that winter water withdrawal can reduce the amount of dissolved oxygen available for fish (Cott et al. 2006), although changes are not apparent at current levels of withdrawal on the North Slope (Hinzman et al. 2006). Natural lake properties in the Arctic have been the best predictors of oxygen depletion during the winter, rather than pumping (Chambers et al. 2006). There is some progress in modeling under-ice dissolved oxygen levels that may be beneficial for future decisions regarding withdrawal quantities (White et al. 2006).

The provisions under Alternative A regarding lakewater withdrawals are set conservatively in an attempt to adequately protect fish overwintering habitat. Regulated lake water withdrawal could kill small numbers of fish but would not be expected to have a measurable effect on freshwater, anadromous, and amphidromous fish populations in general.

Effects from Exploratory Drilling

Drilling operations require large amounts of water for blending into drilling muds, and also produce large amounts of rocks and cuttings. If an exploratory well were to be abandoned, drilling muds and cuttings would be re-injected into the bore hole. If the well were to go into production, muds and cuttings would be removed to an approved disposal site at Prudhoe Bay. Any chemical leaching into surrounding waters by cuttings temporarily being stored at the drill site could affect nearby fish habitat. This potential threat would be reduced by Lease Stipulation 28, which prohibits exploratory drilling in rivers, streams, and lake beds, as determined by the highest high water mark. Exceptions could be authorized by the AO in cases of shallow lakes that freeze to the bottom, do not support large fish populations, and are hydrologically isolated. Regulations would also require the proper handling of all well-waste products.

In general, exploratory drilling under Alternative A is not expected to have a measurable effect on freshwater, anadromous, and amphidromous fish populations in and adjacent to the planning area.

Effects from Gravel Extraction. Oil field development requires the construction of stable, elevated gravel pads to hold well heads, pipelines, production facilities, support buildings, and roadways. Gravel has historically been the preferred material for pad and road construction. Construction of a typical gravel pad requires from 8,000 to 12,000 cubic yards of gravel per acre of footprint while the typical roadway requires 30,000 to 50,000 cubic yards of gravel per mile. Unlike in development areas east of the Colville River, gravel deposits are scarce in the planning area (USDOI BLM and MMS 1998); they are most commonly found in riverbeds and floodplains. Potential gravel sources for future development might include importing gravel from borrow sites east of the Colville River, extracting gravel from existing sites, processing bedrock, or using sand/silt/foam composites. Gravel sites within the planning area would be most commonly found in riverbeds and floodplains.

In general, gravel extraction within the planning area would not be likely to have an effect on overwintering and spawning grounds. However, if mining activities were conducted in these sensitive areas, the localized impacts could be substantial, possibly resulting in spawning failure and high mortalities of overwintering fish. Other detrimental affects that could occur during the open-water summer season include the blocking and rerouting of stream channels and increased silt concentrations resulting in reduced primary production, loss of invertebrate prey species, and disruption of feeding patterns for sight-dependent feeders (USDOI BLM 1989). Because gravel spawning areas are limited within the planning area, there may be an association between these sites and optimal gravel extraction sites, increasing the probability that spawning grounds could be impacted.

One of the beneficial aspects of mining in or near riverbeds and floodplains is that it creates deepwater pools. Extensive studies by the ADFG have shown that these pools may be used by fish to overwinter and spawn once the active site is abandoned (Hemming 1988, 1990, 1991, 1993, 1994, 1995; Hemming et al. 1989). Site reclamation could include constructing or enhancing access channels from surrounding streams and rivers. Therefore, properly planned and placed gravel extraction sites could provide fish with substantial and sustainable overwintering habitat in the future.

With the aforementioned considerations in mind, Lease Stipulation 40 prohibits gravel mine sites within the active floodplain of any river, stream, or lake unless the AO determines that there is no other alternative or that the site would ultimately enhance fish habitat. Mine site development and rehabilitation would follow the procedures outlined in North Slope Gravel Pit Performance Guidelines (McLean 1993).

Given the scarcity of gravel sites within the planning area, and the well-defined procedures in place for assessing the potential impact of site development on existing overwintering habitat and migratory corridors, any negative effect of mining on fish stocks would likely be minimal and very localized. Gravel extraction and use associated with Alternative A would not be expected to have a measurable effect on Arctic fish populations in general, and could even have a positive effect by creating new overwintering areas.

Effects from Pad, Road, and Pipeline Construction. Improper placement and construction of drill pads, roadways, pipelines, bridges, and culverts could affect fish and fish habitat by eliminating, diverting, or otherwise impeding flow from small tributaries that connect rivers, streams, and lakes. Altering water flow characteristics could interfere with fish migrations to and from overwintering, spawning, and feeding grounds. Obstructions to fish movement are most common when culverts or low water crossings are not properly sized to allow for the passage of fish during these critical migration periods (Elliott 1982). Movement can be

obstructed during periods of either high or low stream flow. Impacts from culverts can be long-lived (beyond the construction phase) if design and placement are not adequate. Recent investigations into stream crossing structures in the North Slope oilfields found a number of crossings had problems that likely impair or impede fish passage beyond the structures (Morris and Winters 2004, 2007). Obstruction to stream and river flow and fish migrations may also occur if ice bridges are still in place once spring breakup begins.

Lease Stipulation 42 states that bridges, rather than culverts, be used for road crossings on all major rivers, and that any culverts that are necessary on smaller streams be large enough to avoid restricting fish passage or affecting natural stream flow. Lease Stipulation 24(d) requires that snow bridges be removed or breached immediately after use or before spring breakup. Lease Stipulation 41 prohibits the construction of all permanent oil and gas facilities, roadways, airstrips, and pipelines within 500 feet of any active floodplain, unless otherwise permitted by the AO (special habitat zones identified in Lease Stipulation 39 have their own designated restrictions). Lease Stipulation 43 mandates that should the AO approve construction within a floodplain (road and pipeline crossings), natural drainage patterns would be identified prior to and maintained during and after construction.

Other threats to fish and fish habitat associated with gravel-based structures are erosion and subsequent in-stream sedimentation. Heavy sediment loads could silt out spawning areas and smother eggs, or interfere with respiration of newly emergent fry (Cairns 1968). Heavy sedimentation could also affect invertebrate communities that serve as food sources for fish. Whether the sediment loads attributable to pad and roadway erosion would be sufficient to affect invertebrate and fish communities is presently unclear. Denbeste and McCart (1984a, b) found that the excessive introduction of sediments from pipeline-related activities in Atigun Pass did not appear to have any detrimental effect on Atigun River benthic invertebrate communities or local fish communities. With the exception of a seasonal shift in the density in the stonefly Podmosta, the invertebrate benthic communities in the North Fork Chandler River were unaffected by heavy sediment loads associated with pipeline activities (Denbeste and McCart 1984a,b). In fact, chironomid larvae, which are the dominant food item for fish in the North Fork Chandler River, were actually more abundant in turbid waters than correspondingly clear tributaries. Given that high sediment loads characterize many North Slope rivers and streams during breakup and flooding, it is likely that fish and benthic invertebrate communities inhabiting them are somewhat adapted to frequent exposure to heavy sedimentation.

Erosion and sedimentation would also be controlled through the use of road surfacing techniques, adequate drainage configurations, adequate cross-drainage, and vegetation. Furthermore, Lease Stipulation 41 provides for a buffer zone by prohibiting the construction of all permanent oil and gas facilities, roadways, airstrips, and pipelines within 500 feet of any active floodplain, unless otherwise permitted by the AO (special habitat zones identified in Lease Stipulation 39 have their own designated restrictions). Any impacts from erosion should be short term, and proper placement of these structures, in combination with adequate and properly sited drainage systems, should minimize effects to fish.

Pipeline construction within the planning area would depend on the location and sequence of commercial-sized discoveries. Narrow streams could be crossed using elevated pipelines on suspension spans. Wider, shallow rivers could be crossed by trenching and burying insulated pipelines in the riverbed. All entrenched crossings would be constructed in the winter at locations selected to minimize disturbances to overwintering fish habitat. Once installed, suspended and entrenched pipelines would have no effect on stream and water flow

characteristics within the planning area unless maintenance or integrity issues occurred. All pipelines would be routed to avoid lakes, where feasible. The effects of pipeline leaks are discussed below under the "Effects of Spills" subheading.

Collectively, the lease stipulations and design requirements described above should provide adequate protection to the integrity of natural flow characteristics and water quality within the planning area. The construction and placement of drill pads, roadways, pipelines, bridges, and culverts under Alternative A is not expected to have a measurable effect on freshwater, anadromous, and amphidromous fish populations in and adjacent to the planning area.

Effects from Summer Tundra Travel. Alternative A allows summer tundra travel in Northeast NPR-A only through use of the stipulation exception process (see stipulation 24i in the 1998 Northeast NPR-A ROD). Travel off of gravel pads is easiest in winter and generally environmentally preferable at that time, but some vehicle travel off of pads does occur in North Slope oil fields during summer to accomplish specific tasks. The State of Alaska has approved some low-ground-pressure vehicles for summer tundra travel and similar summer tundra travel may be anticipated to be part of oil development in northeast NPR-A.

The potential impacts on fish related to summer tundra travel include sedimentation and degraded water quality. If vehicles cross streams, increased sedimentation could occur from streambank damage and disturbance of the streambed, and small leaks from equipment (e.g. fuel or mechanical fluids) could degrade water quality. However, stream crossings would likely be rare and only approved in the exception process if adequate protection was granted to fish habitat. If a stream crossing was allowed, a short-lived sediment pulse from disturbing the streambed would have a very short-lived effect on the stream. Any accidental small leak from a vehicle would not have a discernible impact on fish. Under Alternative A, limited summer tundra travel would not have a measurable effect on freshwater, anadromous, or amphidromous fish populations within and adjacent to the planning area.

Effects from Causeways. The construction of solid gravel causeways along the coast has long been a sensitive fisheries issue (USACE 1980, 1984). These structures, which can extend several miles out to sea, are used for offshore drilling, year-round seawater extraction, and as docking facilities for sea-born supply. Their solid construction enables them to withstand the immense pressures of shifting coastal ice in late winter and spring. They also have the potential to physically block fish moving along the shore and/or alter coastal circulation and mixing patterns such that hydrographic conditions becomes inhospitable for anadromous and amphidromous fishes. The nearshore coastal zone is a prime summer feeding ground for these species. Studies conducted at Prudhoe Bay have documented some instances in which causeways have indeed altered, impeded, and even completely blocked anadromous and amphidromous fish from migrating along the coast (Fechhelm 1999; Fechhelm et al. 1989, 1999).

BLM discourages the use of solid-fill causeways, preferring instead alternatives such as onshore directional drilling, elevated structures, or buried pipelines. Lease Stipulation 30 prohibits the construction of causeways, docks, artificial gravel islands, and bottom-founded structures in river mouths and deltas, and the construction of artificial gravel islands and bottom-founded structures in active stream channels, unless otherwise approved by the AO on a site-specific basis. If any such structures were approved, they would be designed, sited, and constructed in a way that would prevent large changes in nearshore hydrography and maintain free passage of marine, anadromous, and amphidromous fishes. Prohibiting causeways and docks in river mouths and deltas would offer further protection to migratory and marine fish species feeding

in nearshore waters. Any future construction of a causeway or dock would be approached with great caution. Overall, the construction of causeways under Alternative A is not expected to have a measurable effect on anadromous and amphidromous fish populations in and adjacent to the planning area.

Effects from Waterflooding. Waterflooding is a process that can increase oil recovery from production wells. Water is injected into selected areas of the reservoir to maintain subsurface pressure and promote fluid flow up to the surface. The process requires such vast amounts of water that the high demand usually overwhelms local freshwater sources. Therefore, seawater is used instead. Waterflooding systems consist of seawater intake and treatment plants located on the coast and an insulated pipeline that carries the seawater from the plant to production wells in the field. Oil fields in the northern portion of the planning area would likely receive seawater from facilities already serving fields in the Prudhoe Bay/Kuparuk area. The Prudhoe Bay Waterflood facility, constructed in 1981, can supply 92.4 million gallons of seawater per day. There are also seawater intakes at Endicott (11.6 million gallons per day), and Kuparuk (25.2 million gallons per day).

One of the initial issues surrounding the construction of these seawater intake facilities was the number of anadromous, amphidromous, and marine fish that might be entrained by the seawater intake. Seawater intakes are constructed with ports fronted by a concrete wall that descends from the surface of the water to a depth of 23 feet. These ports are designed to exclude ice from being entrained, but their presence also means that fish must pass under the 23-foot-deep barrier to reach the intake ports. Intakes are fitted with filter and diversion screens to prevent fish from entering them (Dames and Moore 1985-1988). The filter and diversion screens also contribute to very low velocity intake currents (Moulton 2004). Monitoring of the intakes and marine bypass systems was conducted for the Prudhoe Bay and Kuparuk waterflood facilities from 1984 to 1987 to assess entrainment and impingement effects on fish (Dames and Moore 1985-1988). Fish were rarely observed during the monitoring studies, and most of those that entered the system passed successfully. The results indicated that the intakes were performing as designed, and monitoring was discontinued after 1987.

The seawater intake facilities that would serve much of the planning area have been operational for years, and have apparently had no serious effects on fish migrating or foraging in the intake area. If seawater intake facilities were constructed in the future to enhance supply to oil fields in the planning area, it is assumed that the same design safeguards would be incorporated to prevent the entrainment and impingement of fish. It is not expected that seawater intake systems would have a measurable effect on anadromous and amphidromous fish populations under Alternative A.

Effects of Abandonment and Rehabilitation

Water withdrawal and removal of bridges, culverts, bridge approaches, pads, and roads could have impacts on fish similar to those described for construction activities. Additional fish habitat could be created by allowing gravel pits to be colonized by fish from nearby streams.

Effects of Spills

The effects of oil spills on fish have been discussed in previous Beaufort Sea EISs (e.g., Sale 144 Final EIS; USDOI MMS 1996c), 1998 Northeast IAP/EIS (USDOI BLM and MMS 1998), and Northwest IAP/EIS (USDOI BLM and MMS 2003), and these are summarized here. Oil spills have been observed to have a range of effects on fish (Malins 1977; Hamilton et al. 1979; Starr

et al. 1981). The specific effect depends on the concentration of petroleum present, the length of exposure, and the stage of fish development involved (eggs, larva, and juveniles are most sensitive). If lethal concentrations are encountered (or sub-lethal concentrations over a long enough period), fish mortality is likely to occur. However, mortality caused by a petroleum-related spill is seldom observed outside the laboratory environment. Most acute-toxicity values (96-hour lethal concentration for 50% of test organisms [LC50]) for fish generally are on the order of 1 to 10 ppm. Concentrations measured under the slicks of oil spills at sea have been less than the acute values for fish and plankton. For example, concentrations of oil 1.5½ to 3.3 feet beneath a slick from the Tsesis spill ranged from 50 to 60 parts per billion (ppb; Kineman et al. 1980). Extensive sampling following the Exxon Valdez oil spill (about 260,000 bbl in size) also found hydrocarbon levels that were well below those known to be toxic or to cause sub-lethal effects in plankton (Neff 1991). The low concentration of hydrocarbons in the water column following even a large oil spill at sea appears to be the primary reason for the lack of lethal effects on fish and plankton.

If a fuel spill of sufficient size were to occur in a small, fish-containing body of water with restricted water exchange, lethal and sub-lethal effects would be expected on most of the fish and food resources in that waterbody. Mortality would be higher for larval fish because they are relatively immobile and are often found at the water's surface where oil concentrations would be high. Substrate contamination in spawning areas could result in high egg morality. Sublethal effects would include changes in growth, feeding, spawning, and reduced fitness. Adults might be able to avoid contact with oiled waters during a spill in the open-water season, but survival would be expected to decrease if oil were to reach an isolated overwintering pool. Even lightly contaminated water, which might otherwise be insufficient to elicit lethal or sub-lethal effects in fish in an open-water environment, could have more detrimental impacts in confined overwintering areas. If sub-avoidance levels of contamination allowed fish to converge on an overwintering site, those fish would be forced to endure low-level conditions continuously over the entire winter. The time frame of contamination could also be highly variable. Stream flow begins in late May to early June as a rapid flood event that, in conjunction with ice and snow damming, can inundate extremely large areas in a matter of days. The flushing effect of the spring runoff could purge contaminants from rivers and streams, and possibly low-lying or open access lakes.

It is estimated that from 65 to 80% of crude oil spills associated with oil production would occur on a drilling pad (USDOI BLM and MMS 1998). Drilling pad oil spills are typically small and easily cleaned up. Lease Stipulation 41 prohibits the construction of all permanent oil and gas facilities within 500 feet of any active floodplain unless otherwise permitted by the AO. This buffer zone is designed to provide protection to surrounding water bodies. Crude-oil spills occurring on production pads are likely to have little or no effect on the surrounding environment and fish communities. The approximately 20 to 35% of crude-oil spills that occur off pads are typically associated with pipeline leaks. These spills generally remain restricted to an area of the tundra where they are more easily contained and cleaned up. Many off-pad spills make contact with snow, which can then be cleaned up before the oil reaches the tundra or waterways. Some spills could reach nearby streams, rivers, or lakes, but the volume of these spills would typically be small. Some fish in the immediate area of a spill could be affected, but the impact would largely remain localized. If the flow characteristics of surrounding waterbodies were sufficient to disperse the spill over a wider area, it would also have a diluting effect on what is already likely to be a small volume spill. Further, oil spill contingency plans and rapid response mechanisms are an integral part of the leasing process. These include required contingency plans that established procedures to insure prompt response, notification, and cleanup of any spill (Lease Stipulations 7, 8, 9, and 13), annual spill response-training

(Lease Stipulation 11), and spill-response field drills (Lease Stipulation 12) for all spill-response personnel. Lease Stipulation 38 requires that all pipelines be constructed with the best technology for detecting corrosion and leaks.

Because of the small volumes involved, management practices, and the substantial emphasis that is placed on oil-spill response plans and procedures, small crude-oil spills associated with Alternative A would not likely have a measurable effect on freshwater, anadromous, or amphidromous fish populations in or adjacent to the planning area. Besides the effectiveness of the response, many independent factors will determine the probability that fish will be negatively impacted by an oil spill, including the quantity spilled, season, weather patterns, location (e.g. upland versus river channel), and proximity to sensitive habitat (see section **4.2.2.3, Fate and Behavior of Spilled Oil**). If a large spill of crude oil occurred during the summer open-water period and within a major stream or river channel, this could potentially have an effect on freshwater, anadromous, or amphidromous fish populations in or adjacent to the planning area; in particular, impacting subpopulations at the drainage level. A very large oil spill within a major stream or river channel during the summer would have an even more likely impact on freshwater, anadromous, or amphidromous fish populations in or adjacent to the planning area. Impacts to fish from all projected oil spills under Alternative A would have the least impact as compared to Alternative B, C, and D.Typical refined-oil spills consist of aviation fuel, diesel fuel, engine lube, fuel oil, gasoline, grease, hydraulic oil, transformer oil, and transmission oil. Diesel spills constitute 61% of refined-oil spills by frequency, and 75% by volume. Refined-oil spills occur in conjunction with oil exploration, and production and spill rates correlate directly with the volume of crude oil produced. Based upon oil-spill estimates, the average refined-oil spill is 29 gallons (USDOI BLM and MMS 1998). As described above for crude-oil spills, the small volume involved would, at worst, have a very localized effect on the surrounding environment and fish communities. There are also a number of lease stipulations that would further guard against refined-oil discharges. In addition to Lease Stipulations 7, 8, 9, 11, 12, and 13 described above for crude-oil spills, Lease Stipulation 10 requires that oil-clean-up material be stored at all fueling points and vehicle maintenance areas, and be carried by all vehicles moving overland. Lease Stipulation 14 requires that, except during overland moves and seismic operation, fuels and liquid chemical in excess of 600 gallons (single tank) and 1,320 gallons (multiple tanks) be stored within impermeable liners capable of containing 110% of stored volume. Fuel stations would have impermeable protection against overfills and spills. Excluding small caches of up to 210 gallons for boats and float planes, fuel storage areas would not be located within 500 feet of any waterway. Lease Stipulation 15 prohibits fuels from being stored on an active floodplain or on lake or river ice. Lease Stipulation 17 requires that all fuel containers be properly marked and contents identified. Lease Stipulation 16 prohibits refueling within 500 feet of any water body or in any active flood plain, but with exceptions for boats, float planes, and ski planes. Lease Stipulation 24(n) prohibits fueling equipment from entering the active floodplain of any waterbody. Given the small quantities of fuel involved and the safety requirements for operations on the oil field, it is not expected that refined-oil spills associated with Alternative A would have a measurable effect on freshwater, anadromous, or amphidromous fish populations in or adjacent to the planning area.

Lease Stipulation 5 protects fish and their habitats by regulating the intentional discharge and disposal of wastewater. Unless authorized by a NPDES permit, disposal of domestic wastewater into freshwater bodies would be prohibited. Surface disposal of reserve-pit fluids would also be prohibited unless otherwise authorized by the AO. Only subsurface disposal of produced fluids would be allowed in upland areas and wetlands unless otherwise authorized by the AO. Therefore, it is not expected that intentional discharges would have a measurable effect on

freshwater, anadromous, or amphidromous fish populations in or adjacent to the planning area under Alternative A.

Commercial Gas Development

The winter construction of a buried gas pipeline by trenching through fish inhabited streams or portions of streams not frozen to the bottom would impact fish to some degree. The extent of the impact would depend on the volume of the overwintering habitat and the density of fish utilizing this habitat. Because water freezes to a depth of about 6 feet during a typical winter, much of the overwintering habitat available to fish consists of isolated pools. Where this habitat is sufficiently large or fish density is relatively low, impacts would likely be limited to temporary displacement of fish during the construction phase, with only a minor loss of energy reserves by individual fish. In smaller pools where lateral movements would be restricted or where fish density is relatively high, the impacts would be the greatest. In this case, numerous flight responses and heightened stress due to persistent disturbance from construction activities would likely lead to some mortality and, otherwise, reduced fitness during spring breakup which could hinder the ability to make the seasonal migration to summer feeding habitat. Also, in overwintering pools that are relatively small, turbidity caused by trenching would have a greater magnitude of impact. Potential impacts to fish associated with maintenance of gas pipelines would be similar to those described for construction. Required maintenance due to problems with structural integrity could be expected, which could include portions buried under streams. For instance, a gas pipeline to Nuiqsut from existing oil infrastructure to the east that is buried under the Colville River Nigliq Channel is requiring excavation for repairs in 2007. It was only installed a few years earlier and has not yet been used to transport gas. While these construction and maintenance activities could lead to localized fish mortality, impacts to fish could be largely avoided by burying pipeline in shallow portions of streams or rivers that freeze to the bottom.

Additionally, water withdrawals and changes to hydrology caused by ice roads could affect fish. Potential issues include losing access to suitable habitat, barriers to movement, or habitat degradation. These ice roads would be necessary during both natural gas exploration and construction phases. For example, ice roads would be used to reach exploration drilling sites and also used in trenching the pipeline route or construction of a compressor station (ADNR, 2006b).

If a buried gas pipeline ruptured and gas escaped to a fish-bearing waterbody, some fish in the immediate vicinity might be killed. Natural gas and condensates would be hazardous to any organisms exposed to high concentrations. In general, very few fish are likely to be affected by a pipeline rupture.

While natural gas exploration and development may have notable localized impacts, it is not likely to have a measurable effect on freshwater fish populations.

4.3.7-a.3 Effectiveness of Stipulations

Numerous lease stipulations were identified in the 1998 Northeast IAP/EIS ROD to effectively protect water quality and fish. Lease Stipulation 5 minimizes impacts to fish and their habitats by regulating the intentional discharge/disposal of wastewater. Lease Stipulations 7 through 17 and 24(n) would provide increased protection to fish and fish habitat from oil spills and during use, handling, and storage of refined oil products. Lease Stipulations 19 and 24 provide

guidelines for, and limit the extent of, winter activities that could harm fish overwintering habitat. Lease Stipulation 20 helps mitigate impacts to overwintering fish and their habitat by limiting the withdrawal of water from rivers and streams during winter. Lease Stipulation 28 prohibits exploratory drilling in rivers, streams, and lakebeds. These steps would provide increased protection to fish habitat from unexpected drilling discharges, spills, and well waste. Lease Stipulation 30 limits the construction of causeways, docks, artificial gravel islands, and bottom-founded structures in river mouths and deltas; and the construction of artificial gravel islands and bottom-founded structures in active stream channels. Lease Stipulation 40 minimizes damage to fish habitat by restricting the mining of gravel within the active floodplain of any river, stream, or lake. However, mining could be approved if it could be demonstrated that the site would ultimately enhance fish habitat. Lease Stipulations 41, 42, and 43 require that natural drainage patterns within the planning area be identified and maintained during and after construction of all permanent oil and gas facilities, roadways, airstrips, pipelines, bridges, and culverts. Lease Stipulation 41, which prohibits the construction of all permanent oil and gas facilities, roadways, airstrips, and pipelines within 500 feet of any active floodplain unless otherwise permitted by the AO, also establishes a buffer zone to protect fish habitat from unplanned spills or discharges and sedimentation from gravel-based structures. Lease Stipulation 38 requires that all pipelines be constructed with the best technology for detecting corrosion and leaks.

4.3.7-a.4 Conclusion

The potential impacts to freshwater, anadromous, and amphidromous fish from oil exploration and development activities within the planning area under Alternative A include winter seismic activities near sensitive overwintering habitats; loss of overwintering habitat from water withdrawals; degradation or blockage of water bodies used as fish migratory corridors or feeding grounds resulting from the construction and placement of pipelines, pads, ice and gravel roadways, airstrips, and causeways; loss or degradation of habitat from gravel extraction; crude and refined-oil spills; and loss or degradation of habitat from gravel structure erosion. Rigorous management and safety practices, planning requirements, and adherence to Federal and state operational guidelines, procedures, and lease stipulations, including those specifically targeted for the planning area, are sufficient to minimize impacts from these sources (USDOI BLM and MMS 1998). While impacts from any of the above activities could affect small numbers of fish in a localized area, in the absence of a catastrophic spill oil exploration and development activities that would occur under Alternative A are not expected to have a measurable effect on freshwater, anadromous, and amphidromous fish populations in and adjacent to the planning area.

The threat of localized oil and gas activities affecting local fish populations would increase if these activities occurred in particularly sensitive habitats, such as Teshekpuk Lake (least cisco and broad whitefish), the Tingmiaksiqvik River (broad whitefish and Arctic grayling), the Ikpikpuk and Miguakik rivers (broad whitefish, burbot, and Arctic grayling), Fish and Judy creeks (least cisco, broad whitefish, and Arctic grayling), and the deep water lakes. Although adjacent to, but not directly in, the planning area, the lower reaches of the Colville River Delta, including the Nigliq Channel, serve as the primary overwintering area for Arctic cisco and should be considered an especially sensitive area for planning purposes. Channels in the Colville River also serve as the primary migratory pathways for Dolly Varden.

In general, impacts to fish from non-oil and gas activities, and from oil and gas activities, would likely be additive, except in those areas where the two types of activities overlapped. Impacts to fish from exploration and development activities would also be additive, except where

development activities occurred in areas previously disturbed during exploration. However, once exploration and development/production cease in an area, fish populations and habitat could recover, reducing overall effects in the planning area.

4.3.7-b Marine Fish

Nearly all of the 49 species of marine fish reported to inhabit the Beaufort Sea have a predominantly offshore, marine distribution year round. Eight principal species move into coastal waters adjacent to the planning area during summer (Table 3.3-B and Appendix H). The most abundant of these are Arctic cod, fourhorn sculpin, and Arctic flounder; with the latter two species known to travel considerable distances upriver.

As a preface to the following, it should be noted that marine fish species that inhabit nearshore coastal water during summer have extensive and widespread distributions along the coast. Fourhorn sculpin and Arctic flounder are typically among the most abundant species collected along the Beaufort Sea throughout Alaska and Canada (Kendel et al. 1975; Woodward-Clyde Consultants 1984; Bond and Erickson 1985, 1987; Moulton et al. 1986a; Philo et al. 1993a; Underwood et al. 1995; Griffiths et al. 1996; Fechhelm et al. 2000). Arctic cod are so abundant in marine waters of Arctic Canada and Alaska that Frost and Lowry (1983) believe that they are the most important consumer of secondary production in the Alaskan Beaufort Sea. Given their widespread distribution and abundance throughout the Beaufort Sea, it is highly unlikely that any point impact associated with oil and gas development could affect these marine species at the population level. The exception might be a catastrophic oil spill that was non-lethal to marine species in general, but which could cause sublethal genetic or physiological abnormalities that might be propagated through the broader population.

4.3.7-b.1 Activities Not Associated With Oil and Gas Exploration and Development

As described above for freshwater, anadromous, and amphidromous fishes, non-oil and gas activities would be quite limited in scope and duration. In addition, recreational and commercial fishermen do not target marine fish in the Beaufort Sea. Therefore, it is not expected that non-oil and gas activities occurring under Alternative A would have a measurable effect on marine fish in the vicinity of the planning area.

4.3.7-b.2 Oil and Gas Exploration and Development Activities

The following discussion of impacts from oil and gas activities includes impacts to marine fish and habitat within and adjacent to the planning area. This area is largely limited to the coastal zone and the lower reaches and deltas of some of the larger rivers during the open-water summer season.

On June 19, 1997, the U.S. Supreme Court decided in U.S. v Alaska No. 84 that the NPR-A included tidally influenced waters and the submerged lands underlying them. Given the relatively small tidal fluctuations characteristic of the Beaufort Sea, most of the coastal tidal area of the NPR-A is shallow and lies within the landfast ice scour zone in winter. For some of the following discussions, it is assumed that the marine habitat and the fish occupying it are outside the NPR-A proper during winter.

Effects of Disturbances

Effects from Seismic Surveys. Seismic surveys would be conducted within the planning area during the winter months from early December to mid-May. Because marine fish and their habitat lie outside the planning area in winter, seismic activities associated with Alternative A are not expected to have a measurable effect on marine fish populations.

Effects from Water Demand. The source of water for building drill pads, roads, and airstrips would likely be freshwater bodies near the site of construction. Therefore, water withdrawal activities would have no effect on marine fish and their environment. Water withdrawal for the purposes of waterflooding does have implications for the marine system and is discussed separately below under the "Effects from Waterflooding" subheading.

Effects from Exploratory Drilling. Exploratory drilling would be conducted within the planning area during the winter months, from early December to mid-April. Because marine fish and their habitat lie outside the planning area in winter, it is not expected that exploratory drilling activities associated with Alternative A would have a measurable effect on marine fish populations.

Effects from Gravel Extraction. If gravel extraction for pad and roadway construction were required in the planning area, it would likely occur in or near riverbeds and freshwater floodplains. Under Lease Stipulation 48, lessees are required to minimize the impact of development on wetlands, which includes basin-complex wetlands and coastal wetlands. It is doubtful that gravel extraction would be permitted along the coastal tidal zone. Small numbers of fourhorn sculpin and Arctic flounder could migrate upriver in summer, but any encounter with a gravel site would be a chance occurrence, and would involve only a minuscule segment of any population. Fourhorn sculpin and Arctic flounder regularly inhabit and forage in highly turbid coastal waters near river outfalls and plumes. Under Alternative A, it is unlikely that gravel extraction within the planning area would have a measurable effect on marine fish. In addition, gravel extraction would not potentially create overwintering habitat as it might for freshwater fish, since all marine fish overwinter at sea.

Effects from Pad, Road, and Pipeline Construction. Pad, road, and pipeline construction would largely be limited to freshwater habitat regions of the planning area, and would not establish a footprint in marine or coastal habitats. Lease Stipulation 48 requires that lessees minimize the impact of development on wetlands, which includes basin-complex wetlands and coastal wetlands. Future exceptions could be the construction of docking facilities along the coast of the planning area, although it seems likely that sea borne re-supply would involve the already operational docking facilities at West Dock. BLM's position on causeway construction along the coast is described below. Pad, road, and pipeline construction under Alternative A would not be expected to have a measurable effect on marine fish populations.

Effects from Causeways. The construction of solid gravel causeways along the coast is less of an issue for marine fish than it is for anadromous and amphidromous fish. The major migration for two of the most dominant species, fourhorn sculpin and Arctic flounder, is inland soon after breakup. Once in coastal waters, these sedentary species do not undergo the extensive alongshore migrations up and down the coast that are characteristic of Arctic cisco and the amphidromous species. Potential blockage to alongshore movement is less critical. Arctic cod are so abundant throughout Arctic waters that any localized disruption to their movement would not have a lasting impact on the species. Considering the BLM's regulations on the use, design, and monitoring of causeways that might be constructed along the coast in the future

(see "Freshwater and Anadromous/Amphidromous Fish" above), it is not expected that the construction of causeways under Alternative A would have a measurable effect on anadromous or amphidromous fish populations in and adjacent to the planning area.

Effects from Waterflooding. It is not expected that waterflooding would have a measurable effect on marine fish, for the same reasons that were given above for anadromous and amphidromous fish.

Effects of Spills

Hydrocarbon spills can impact marine fishes of any life history stage. Such impacts may include sublethal and/or lethal effects. The intensity of the effects upon a marine fish population or assemblage of species is dependent on a suite of dynamic factors. The size of the spill does not necessarily directly relate to the number of individuals that could be impacted. Hydrocarbons may be introduced into the coastal/marine environment as a result of marine vessel overboard discharges or facility spills. A detailed and extensive discussion of the potential lethal and sublethal effects of oil toxicity on finfish and other marine organisms is provided in the Northwest IAP/EIS (USDOI BLM and MMS 2003).

The threat to marine fish from an oil spill is contingent upon the spill reaching coastal waters at volumes capable of affecting large nearshore areas. Because oil spills in the planning area are expected to be small, and given the stringent oil-spill-response safety requirements for operations on the oil field (see "Freshwater and Anadromous/Amphidromous Fish" above), there is a very low likelihood that an inland spill would reach coastal/marine waters of the planning area at volumes capable of causing a biologically important or measurable impact to marine fishes. Therefore, Lease Stipulations 7 through 17 and 24(n), which provide increased protection to freshwater, anadromous, and amphidromous fish and fish habitat from oil spills and during fueling use, handling, and storage of refined oil products, would also serve to protect marine fish and their habitat. Lease Stipulation 5 prohibits the discharge of produced waters into open or ice-covered marine waters less than 33 feet in depth. However, discharge in deeper water could be approved by the AO.

4.3.7-b.3 Effectiveness of Stipulations

In general, most of the lease stipulations associated with Alternative A are designed to minimize impacts to the freshwater, anadromous, and amphidromous fish within and adjacent to the planning area. Lease Stipulation 48 provides some protection to the marine environment by requiring that lessees minimize the impact of development on wetlands, which includes basin-complex wetlands and coastal wetlands. Lease Stipulations 7 through 17 and 24(n), which provide increased protection to waterbodies within and adjacent to the planning area from oil spills and during fueling use, handling, and storage of refined oil products, would also protect marine fish and their habitat. Lease Stipulation 5 minimizes damage to marine habitats by regulating the discharge of produced waters into open or ice-covered marine waters.

4.3.7-b.4 Conclusion

In general, marine fishes of the Beaufort Sea are insulated from many potential environmental impacts associated with oil development in the planning area. Most of the coastal tidal area of the planning area is shallow and lies within the winter landfast ice scour zone. Thus, the marine habitat and the fish occupying it are outside the planning area during winter and would not be subject to disturbances associated with seismic surveys, exploration drilling, and water

withdrawal. Although species like fourhorn sculpin and Arctic flounder may move upriver during summer, most members of these marine species remain in shallow coastal waters. The bulk of the population would not be directly subject to the effects of river gravel extraction, pad, road, and pipeline construction, sedimentation from gravel erosion, and the potential blockage of migratory corridors. Rigorous management and safety practices, planning requirements, and adherence to Federal and state operational guidelines, procedures, and lease stipulations, including those specifically targeted for the Northeast NPR-A, would further minimize the potential for impacts to marine fish from these sources.

Because marine species are abundant and widely distributed throughout the Beaufort Sea, it is also highly unlikely that any point impact associated with oil development in the planning area (the occurrence of which is unlikely) could affect these species at the population level. One exception might be a catastrophic oil spill that could cause sublethal genetic or physiological abnormalities that might be propagated through the broader population. However, given that oil spills in the planning area are expected to be small, and stringent oil-spill-response safety requirements for operations on the oil field would be in place, such an event is unlikely.

Overall, it is not expected that oil exploration and development activities under Alternative A would have a measurable effect on marine fish populations in or adjacent to the planning area. Since nearly all exploration and development activity would occur onshore under all alternatives, impacts to marine fish resources under Alternative A would be minor and similar to, or slightly less than, those that could occur under Alternatives B, C, and D.

4.3.8 Birds

This section discusses the potential effects to non-threatened and non-endangered bird species that could result from management actions in the planning area under Alternative A; a discussion of effects to threatened bird species is given in **section 4.3.10, *Threatened and Endangered Species*.** Approximately 80 species of birds commonly or regularly occur in the planning area. Most of these species, including loons, waterfowl, shorebirds, raptors, passerines, seabirds, and ptarmigan, are migratory and occur in the planning area only during the summer breeding season. Most of the activities that could potentially affect birds in the planning area would result from oil and gas exploration and development. Other activities that could potentially affect birds in the planning area include subsistence activities (including hunting, fishing, berry picking etc.), recreational use, activities associated with scientific surveys and research camps, clean up of old oil and gas exploration sites, and activities associated with government actions (e.g. clean up of abandoned well sites). These activities could affect tundra nesting birds by causing: 1) temporary or permanent habitat loss; 2) various types of disturbance related to equipment and facility noise, vehicular and air traffic, and pedestrian activities, which could result in displacement from preferred foraging, staging, nesting and/or brood-rearing habitats or decreasing productivity and survival; 3) increased predation from predators attracted to areas of human activity; and 4) mortality resulting from collisions with vehicles or structures, or exposure to contaminants, including oil spills. Under Alternative A, Teshekpuk Lake and virtually all of the Goose Molting Area north and east of the lake would be unavailable for oil and gas leasing, and no surface activity would be allowed in a 5 to 6 mile band around the southern portion of the Goose Molting Area (Maps 2-1, 3-14). In addition, lease stipulations have been designated under this alternative that would help to mitigate potential negative impacts that could result from the various activities.

4.3.8.1 Activities Not Associated With Oil and Gas Exploration and Development

Effects of Disturbance

Seasonal Camps. Ground camps associated with non-oil and gas activities include small groups of people involved in scientific research or recreation. These camps range in size from small mobile parties that remain at a site for a few days to larger camps that are set up for longer time periods. The majority of these camps would occur during the summer. Winter camps would have little impact to birds given that few birds occur in the planning area during winter. Various types of disturbances could affect tundra nesting or brood-rearing birds near summer camps. Noise and ground activities could disturb feeding, nesting, or brood-rearing birds, causing temporary or permanent displacement from feeding or nesting areas and potentially affecting energy budgets and productivity. Displacement from brood-rearing areas could lead to higher predation rates. Although pedestrian traffic has been shown to be particularly disruptive to some waterfowl and raptors (Roseneau et al. 1981; Ritchie 1987; Johnson et al. 2003b), some birds may also acclimate to predictable daily activities of camp personnel. Aircraft activity to mobilize and re-supply summer camps could disturb birds along continually-used flight corridors and near airstrips during take-offs and landings. Effects of this type of visual and noise disturbance could range from temporary displacement from preferred habitats to nest abandonment. Fixed-wing and helicopter flights for mobilization and re-supply of summer camps would be intermittent, and could occur several days or weeks apart. It may be easier for birds to acclimate to flights that occur on a regular daily basis than to flights that occur on a more random basis. Birds could also suffer mortality due to collisions with aircraft. Disturbance to birds from aircraft traffic and camp activities would likely have the greatest effect within approximately 695 meters (2,280 feet) of the camps and little or no effect beyond 1,981 meters (6,500 feet; Johnson et al. 2003b). Ward et al. (1999) studied brant response to fixed-wing and rotary-wing aircraft and reported that 75% of brant flocks responded to overflights with more flocks responding to rotary-wing (51%) than to fixed-wing (33%). Responses to overflights occurred up to 1,219 meters in altitude and a lateral distance to 4.8 km (3 miles), although the majority of birds responded to aircraft that were within a lateral distance of 0.8 km (½ mile) or less (Ward et al. 1999). The greatest response to aircraft altitude occurred between 305 and 762 meters (1,000 and 2,500 feet). Tundra-nesting birds near summer camps could suffer mortality or egg loss due to predation by predators attracted to anthropogenic sources of food at camps. Nest abandonment could occur if nests are located in areas with high levels of activity. If possible, summer camps should be located in areas away from habitats used by species of special agency concern, such as brant, yellow-billed loon and buff-breasted sandpiper, and species with declining population trends on the ACP to minimize potential effects of disturbance. Impacts would likely be localized and restricted to within about a mile of activities based at the camp.

River Transport. Summer boat traffic could occur on the Colville, Kogosukruk, Kikiakrorak, and Ikpikpuk rivers for recreational or subsistence activities, or to re-supply camps along these rivers. Numerous studies have reported on the effects of boat disturbance to birds (e.g., McGarigal et al. 1991; Steidl and Anthony 1996); this activity could potentially affect nesting gyrfalcons, peregrine falcons, and rough-legged hawks in the Colville River Raptor, Passerine, and Moose LUEA and the Ikpikpuk River area. The current levels of boat activities on these rivers have apparently not impacted raptors negatively, as some populations, particularly the peregrine falcon population; have been increasing on the ACP in recent years (Ritchie et al. 2003). Fuel spills due to summer boat traffic are expected to be small (less than five gallons), and would most likely occur during fuel transfers. Fuel spills have the potential to negatively

impact birds if they occur in areas where the birds are feeding (contamination of prey items) or if fuel comes into contact with and adheres to the birds feathers, often causing death. Unless a fuel spill occurred in an area where large numbers of birds were very congregated any such losses would likely be minor to the bird populations on the North Slope, but would contribute to cumulative effects.

Wildlife Surveys. Aerial surveys for wildlife in the planning area could include fixed-wing aircraft and helicopter surveys for waterfowl. Low-level fixed-wing aerial surveys would probably have little effect on birds due to the short amount of time during which aircraft would be in a particular area. Ward et al. (1999) reported a decreasing level of response to aircraft overflights by brant with increasing lateral distance of aircraft. The majority of birds responded at lateral distances of 0.8 km (½ mile) or less. Wildlife telemetry studies involving the use of helicopters could cause greater disturbance to birds due to the take-offs and landings required for deploying ground personnel for attachment of transmitters. Additionally, pedestrian traffic, necessary for transmitter attachment, has been shown to be more disruptive to some waterfowl species than other types of disturbance (Johnson et al. 2003b). The effects to birds from these activities could range from temporary displacement from preferred feeding habitats to nest abandonment and loss of production for the breeding season. Impacts would likely be localized. Impacts have potential to have greater negative effect if the activity occurs in an area of high bird density (such as near lakes containing large numbers of molting geese) or in areas containing populations of species listed as Threatened under the Endangered Species Act or on the agency sensitive species list.

Waste Removal. Clean-up activities at abandoned sites in the planning area could involve the use of fixed-wing aircraft or helicopters to access remote areas. The effects of this traffic would be similar to those described above for conducting aerial surveys or for mobilizing and re-supplying summer camps. Ground activity by workers on foot could be more disruptive to some bird species than other types of disturbance (Johnson et al. 2003b). Impacts would likely be localized. Impacts have potential to have greater negative effect if the activity occurs in an area of high bird density (such as near lakes containing large numbers of molting geese) or in areas containing populations of species listed as Threatened under the Endangered Species Act or on the agency sensitive species list.

4.3.8.2 Oil and Gas Exploration and Development Activities

Effects of Disturbances

Exploration

Most seismic surveys and exploration drilling activities would occur during the winter months when most birds are not present in the planning area. Therefore, these activities would likely have no direct impacts on most species. A few species, including snowy owl, gyrfalcon, ptarmigan, and common raven, which could be present in the planning area during winter, could be temporarily displaced from preferred feeding areas by oil and gas exploration activities. There is also a potential that ravens could be attracted to seismic camps.

Although unlikely to occur as Teshekpuk Lake is unavailable for leasing in this alternative, the use of airguns for boat-based seismic work in Teshekpuk Lake during the summer could temporarily displace loons and waterfowl from preferred feeding habitats while surveys were being conducted. Disturbance may result not only from airgun use but also from boat activity (Rodgers and Smith 1995). Because setbacks around the perimeter of the lake presumably

would eliminate the potential for disturbance to birds nesting near the lakeshore, only birds using habitats in the open water of the lake would potentially be disturbed. Birds displaced by seismic activities would likely return to preferred habitats after the airgun arrays passed through the area. Effects of use of airguns on forage fish may include stress from fleeing behavior and physical damage or death (**section 4.1.1** this document) potentially resulting in a reduction in the amount of prey available to foraging loons. Disturbance to birds near and nesting on the shoreline could result from support activities, such as use of helicopters to transport personnel and supplies. Disturbance related to support activities could result in permanent or temporary displacement from nesting, feeding, or brood-rearing habitats. Conducting surveys after the completion of the nesting and brood-rearing period would eliminate the potential for nest abandonment and loss of productivity.

Winter exploration activities could indirectly affect tundra-nesting birds during the summer breeding season. Ice-roads, snow trails and ice-pads are used for transportation and storage of drilling and exploration equipment and for exploratory drilling. Construction of these ice-roads, snow trails and ice-pads could temporarily alter tundra habitats by compressing standing-dead vegetation or delaying the growth and development of vegetation, due to protracted ice melt. The altered vegetation could reduce the amount of suitable habitat for nesting birds, but these impacts would be small and would likely persist for 1 or 2 years (Walker et al. 1987a, b). In areas where winter ice-roads and ice-pads were constructed annually, varying the location of the roads and pads as directed under the lease stipulations could help reduce potential impacts to tundra vegetation and bird nesting habitat. Further reduction of impacts would occur if ice road routes followed the wetter habitats to the greatest extent possible without significantly increasing their length (Yokel et al. 2005).

In some cases, equipment could be stored on ice-pads specially designed and constructed to last through the summer and into the following winter. The tundra under the footprint of these ice-pads would be lost as feeding, nesting, or brood-rearing habitat during the course of that season. Locating these summer ice pads in drier areas would help to reduce potential impacts to loons, waterfowl, and some shorebird species associated with wetter habitat types, but could increase the potential impacts to species that use upland habitats such as plovers and buff-breasted sandpiper.

Water used in the construction of ice roads and pads would be withdrawn from deep lakes (>7 feet in average depth) in areas adjacent to the road and pad locations. Winter water withdrawal could alter lakewater levels and adjacent habitats, although flooding and recharge during spring break-up would likely minimize the potential for long-term effects (Rovansek et al. 1996). In the existing area of oil exploration and development in the vicinity of the Northeast Planning Area, pumped lakes have recharged in the spring at levels similar to unpumped lakes (Streever et al. 2001; URS 2001; Baker 2002). These observations are likely transferable to other areas that have a high concentration of lakes; however, areas with sparse lakes will have different watershed dynamics that will require additional study. Lake recharge during spring would probably limit affects on invertebrate populations used for food by birds in the spring though this has not been studied directly. Bergman et al. (1977) and Derksen et al. (1981) reported that lakes with pendent grass had high levels of use by birds and seemed to be important to loons and waterfowl. Avoiding water withdrawal from lakes with pendent grass may reduce potential effects on waterfowl.

Rolligons and track vehicles used during seismic exploration could leave tracks on tundra habitats that would be observable for several years (Kevan et al 1995). These tracks could affect vegetation, soil chemistry, soil invertebrates, and soil thaw characteristics, key components of

bird habitat. The most noticeably affected areas would include terrain with considerable microtopographic relief caused by mounds, tussocks, hummocks, and high-centered polygons. Wet areas are less likely to be affected than dry areas (Walker 1996). Snow acts as a buffer against these impacts; therefore avoiding areas with low snow cover, in addition to using lightweight vehicles, dispersing traffic patterns, and minimizing sharp turns, could help to minimize damage to vegetation and landforms used by birds (Walker 1996).

Predators, such as glaucous gulls, ravens and Arctic foxes, could be attracted to anthropogenic food sources associated with summer maintenance of exploratory drilling and seismic equipment. Garbage and shelter associated with winter exploration activities could also attract predators such as Arctic foxes and ravens, which may cause increased predation pressure on tundra-nesting birds due to increased over winter survival of predators. However, lease stipulations would require proper handling of non-hazardous waste to avoid human-caused changes in predator populations. This policy has apparently been successful at the Alpine field, where Johnson et al. (2003b) reported no increase in the numbers of most predator species after development. The one exception was common raven, which became more common and nested at the Alpine field after development.

Development and Production

Activities on Roads and Pads. Activities related to oil development and production in the planning area, such as vehicle, aircraft, pedestrian, and boat traffic, routine maintenance activities, heavy equipment use, and oil-spill clean-up activities could cause disturbances that would affect tundra-nesting birds. These disturbances could result in temporary or permanent displacement from preferred foraging, nesting, and brood-rearing, molting and staging habitats, decreased nest attendance, nest abandonment, nest predation and increased energy expenditures that could affect the physiological condition of birds and their survival or reproduction. The likelihood for impacts to tundra-nesting birds would vary depending on the type and location of the disturbance, the species and number of individuals in the area, and the time of year. Impacts would be most likely to occur if facilities were located in habitats with high bird concentrations, in areas containing species that are vulnerable to small losses of nests and habitats that may be limiting for a particular species or if species with low population numbers or declining populations were disturbed. Species of particular concern include yellow-billed loon, red-throated loon, Sabine's gull, long-tailed duck, and buff-breasted sandpiper (Lanctot and Laredo 1994; Brown et al. 2000; Donaldson et al. 2001; Larned et al. 2006; Mallek et al. 2006). The Goose Molting Area is an area with high wildlife values that would be unavailable for oil and gas leasing and development under Alternative A.

Most construction activities, including pipeline installation, and gravel mining and placement for oil field infrastructure (i.e., roads, airstrips, and pads, camps, staging areas, and processing facilities), would be conducted during the winter. Industry will be encouraged to use the existing facility/pad at Lonely to unload and stage materials for development instead of constructing new coastal staging sites. With the exception of a few resident species, most birds are not present in the planning area during winter; therefore, there would be little direct disturbance to most birds. Indirect impacts include loss of potential nesting, brood-rearing, molting, staging or foraging habits due to gravel mining and gravel placement on the tundra.

During the summer, birds could be subjected to disturbances caused by vehicular and pedestrian traffic, and by noise from equipment on roads or at facilities, including large trucks hauling equipment and supplies and road maintenance equipment on access roads and pads. In the North Slope oil fields, these types of disturbances have been documented for waterfowl, and

have been shown to have greater effects on greater-white fronted geese, Canada geese and brant feeding close to roads than on geese feeding further away from them (Murphy et al. 1988; Murphy and Anderson 1993). Disturbances would be most prevalent during the pre-nesting period when birds gather to feed in open areas near roads, and during brood-rearing and fall staging when some geese exhibit higher rates of alertness in areas near roads than do birds in undisturbed areas (Murphy and Anderson 1993). Disturbance would occur most often within 160 feet of roads. However, Murphy and Anderson (1993) reported disturbances to birds as far as 500 to 685 feet from roads. Johnson et al. (2003) reported on a study conducted during construction and post-construction periods at the Alpine Development in which they concluded that there was "individual variation in the responses of geese and swans to potential disturbance, and a reduction in response with increasing distance to the source, consistent with a gradient of exposure". Johnson et al. (2003) reported that for a sample of nesting geese at the Alpine Development during the same study the highest rates of response to potential disturbance was caused by airplanes and pedestrians and the lowest rates of response was elicited by vehicles. This same study determined that the highest rate of response to potential disturbance by nesting swans was to pedestrian disturbance (Johnson et al. 2003). Troy (1988) reported that most common shorebird species occurred in lower densities near roads in the Prudhoe Bay oil field than in areas away from roads. This apparent avoidance of roads, however, may have been related to an avoidance of heavily dusted areas on tundra adjacent to roads with high traffic levels rather than an avoidance of vehicular activity itself. Disturbance from vehicular traffic could affect activity and energy budgets and have negative impacts on nest density and success for some birds. Higher shorebird densities may occur in areas near the coast compared to inland areas and disturbance that occurred in coastal areas may have a greater impact on shorebirds than inland disturbances (see Map 3-18).

Some evidence suggests that pedestrian traffic may have a greater impact on some birds than vehicular traffic. During a study of the effects of disturbance related to the Lisburne Development in the Prudhoe Bay oil field, Murphy and Anderson (1993) reported that of the more common sources of disturbance, humans on foot elicited the strongest reactions from geese and swans. Ritchie (1987) reported that pedestrians caused greater disturbance to nesting raptors than other sources of disturbance. Johnson et al. (2003b) reported that aircraft and pedestrians elicited higher responses by nesting geese at the Alpine field than other sources of disturbance. Restricting or reducing the level of foot traffic on gravel roads and pads could help to reduce the potential for disturbance to foraging, nesting, or brood-rearing birds. Waterfowl in general, seem particularly sensitive to disturbance during the flightless wing molt. There appears to be species specific responses to disturbance stimuli; with some species responding at lower stimulus levels and showing greater behavioral responses (Mosbech and Glahder 1991). As a species, brant have been shown to be highly sensitive to various disturbance stimuli throughout the annual cycle including the wing molt period (Owens 1977, Miller 1994, Miller et al. 1994, Ward et al. 1994, Jensen 1990). For molting geese, several studies have documented substantial shifts in behavior, including spatial displacement, resulting from aircraft overflights (Mosbech and Glahder 1991, Jensen 1990). Little is known about response to other forms of disturbance stimuli during the molt period.

Summer Tundra Travel. Alternative A allows summer tundra travel in Northeast NPR-A only through use of the stipulation exception process (see stipulation 24i in the 1998 Northeast NPR-A ROD). Travel off of gravel pads is easiest in winter and generally environmentally preferable at that time, some vehicle travel off of pads does occur in North Slope oil fields during summer to accomplish specific tasks. The State of Alaska has approved some low-ground-pressure vehicles for summer tundra travel and similar summer tundra travel may be anticipated to be part of oil development in northeast NPR-A.

Activities related to summer tundra travel in the planning area could cause disturbances that would affect tundra-nesting birds. This disturbance could result in temporary or permanent displacement from preferred foraging, nesting, molting and brood-rearing habitats, decreased nest attendance, nest abandonment, nest destruction, nest predation and increased energy expenditures that could affect the physiological condition of birds and their survival or reproduction. The likelihood for impacts to tundra-nesting birds would vary depending on the location of the summer tundra travel, the species and number of individuals in the area, and the time of year. Impacts would be most likely to occur if summer tundra travel occurred in habitats with high bird concentrations, in areas containing species that are vulnerable to small losses of nests and habitats that may be limiting for a particular species, during the molt period in areas where large numbers of birds congregate to molt, or if species with low population numbers, or declining populations were disturbed.

Air Traffic. Aircraft, both fixed-wing and helicopter, would provide access for oil and gas-related activities throughout the life of any potential oil field. This could include air support for seismic and exploratory drilling activity; aerial surveys and support for ground surveys of wildlife, archaeological, hydrological, and other resources; road and pipeline route surveys; pipeline inspections; and support for other development, operations, and abandonment activities. The location, timing, and frequency of such flights and the type of aircraft used will be influenced by the phase of oil exploration, development, and operations, the location of any oil discovered, the type of development that might occur, as well as restrictions that BLM and other regulators might place on the lessee or permittee (see **section 4.2.1.2** for a discussion of potential number of flights associated with various activities). The potential for disturbance to waterfowl from aircraft is well documented (e.g., Schweinsburg 1974; Ward and Stehn 1989; Derksen et al. 1992; McKechnie and Gladwin 1993; Ward et al 1999). Johnson et al. (2003b) conducted the most thorough study of aircraft disturbance to waterfowl in the Arctic at the Alpine field. Responses of birds to aircraft included alert postures, interruption of foraging behavior, and flight. Aircraft disturbances could displace birds from feeding habitats and negatively impact energy budgets. Gollop et al. (1974b) and Ward et al. (1999) suggested that helicopters may be more disturbing to wildlife than low-flying fixed-wing aircraft, although Balogh (1997) indicated that fixed-wing aircraft flown at 150 feet AGL often caused spectacled eiders to flush, while helicopters flown at similar altitudes in the vicinity of Prudhoe Bay did not. In a simulation study, Miller (1994) suggested that altering helicopter routes through the Goose Molting Area would likely reduce the impacts of potential weight loss on molting brant substantially. The greatest disturbance to brant would result from flights parallel to the coast and 1 mile inland. Other studies have reported little response by molting waterfowl to aircraft over-flights (Gollop et al. 1974a). Under Alternative A, permanent oil and gas facilities would be prohibited in high value waterfowl habitat surrounding Teshekpuk Lake and most aircraft overflights in this area would likely be at altitudes sufficiently high to avoid disturbance to waterfowl. Aircraft disturbance would be likely to affect waterfowl and other bird groups in portions of the planning area open to development, although under Alternative A, the effects of aircraft disturbance would likely be lower than that of the other alternatives.

The potential effects of routine aircraft flights into airstrips would range from bird avoidance of certain areas to abandonment of nesting attempts or lowered survival of young. The likelihood that noise associated with aircraft would have a negative impact on birds would probably be greatest during the nesting period when the movements of incubating birds are restricted and the molting period when birds may be energetically stress and are know to be sensitive to disturbance. The highest levels of aircraft noise would occur during takeoffs as engines reach maximum power levels. During landings, aircraft noise levels would be reduced as engine power decreased. In the planning area, aircraft activity would likely be greatest during the

construction period, when more personnel and equipment would be transported to areas being developed than during the production period, when activity levels would be reduced (Johnson et al. 2003b).

The Alpine field avian monitoring program was a multi-year project designed to identify the potential effects of noise and disturbance from aircraft on birds nesting near the airstrip and on large waterbirds during brood-rearing (Johnson et al. 2003b). Other sources of disturbance included vehicle and pedestrian traffic, and predators. When compared to pre-construction numbers, waterfowl nests near the airstrip declined in the area within 3,250 feet of the airstrip after construction began (Johnson et al. 2003b). However, the number of post-development nests increased in the area between 3,250 and 5,000 feet from the airstrip. The decline could not be directly linked to disturbance, as other factors, such as lower temperatures and more severe flooding later into the breeding season during construction years, may also have influenced nest densities. During years of heavy construction, white-fronted goose nest sites were apparently displaced to habitats similar to those used prior to construction, but located further from the airstrip. Johnson et al. (2003b) suggested that preferred white-fronted goose nesting habitats in the Alpine field area had not been saturated with nests prior to development, and that suitable nesting habitat was available in areas away from the airstrip.

White-fronted geese showed some changes in distribution in relation to sources of disturbance at the Alpine field, including increased noise levels, aircraft, vehicles, and pedestrians. However, when comparing the nest densities of shorebirds and passerines on intensively studied plots near and away from the airstrip, nest densities of both groups were higher on study plots near the airstrip than on plots greater than 5,000 feet from the airstrip (Johnson et al. 2003b).

At the Alpine field, white-fronted geese at failed nests were more likely to take incubation recesses than geese at successful nests. A higher frequency and duration of recesses may allow for increased predation by jaegers, gulls, ravens and foxes at unattended nests. The probability of taking a recess increased as noise level increased, when aircraft were present, when the number of vehicles decreased, and when pedestrians were present. Geese nesting less than 6,500 feet from the airstrip were more likely to take a recess than birds greater than 6,500 feet from the airstrip. Of the various disturbance types, helicopters were the least predictable because they did not have a restricted flight pattern. Incubating white-fronted geese and tundra swans showed similar response to helicopters and fixed-wing aircraft, although monitored nests were closer to the airstrip than to the helipad. Airplanes and pedestrians elicited the highest rates of response from incubating geese, and vehicles elicited the lowest. Nevertheless, successful white-fronted goose nests were generally closer to the Alpine field airstrip, the flight path, and the nearest gravel source than unsuccessful nests, although most comparisons were not substantially different (Johnson et al. 2003b).

Johnson et al. (2003b) also reported on tundra swans and yellow-billed loons nesting in proximity to the Alpine field airstrip. There was no difference among years in the mean distance of tundra swan nests relative to the airstrip, closest gravel source, or aircraft flight path. In 1998, a tundra swan nested successfully 520 feet northeast of the airstrip, despite daily helicopter activity near the end of the airstrip during late June and early July. Another pair of tundra swans nested successfully from at least 1997 through 2002 at a site approximately 1,470 feet southwest of the airstrip and 470 feet from the infield road. These nests were successful despite their proximity to the airstrip and their locations under the takeoff and approach patterns of aircraft. Disturbance effects of the various components of the Alpine field apparently were not severe enough to cause major changes in tundra swan nest-site selection. Similarly, no

evidence was found that the development affected the distribution and abundance of yellow-billed loon nests located near the airstrip, although the sample size was small. Johnson (1984) reported that at least three successful common eider nests were located within 975 feet of a helicopter pad on Thetis Island that averaged approximately 12 trips per day. Although the potential exists for displacement of some nesting birds near routinely used aircraft landing sites as a result of numerous overflights, landings, and takeoffs, some birds may habituate to routine air traffic.

During post-breeding studies in southwest Alaska, Ward et al. (1999) found that brant responded to fixed-wing and rotary-wing aircraft at a lateral distance to 3 miles, although the majority of birds responded to aircraft that were within a lateral distance of ½ mile or less. The greatest response to aircraft altitude occurred between 1,000 and 2,500 feet. Derksen et al (1992) also reported that molting brant in the Teshekpuk Lake Goose Molting Area were disturbed by helicopter overflights and that brant did not habituate to the overflights. Low-level helicopter survey flights to monitor pipelines for potential oil spills or leaks could also disturb tundra-nesting or post-breeding birds. Routine flights would be of short duration and occur in a particular area, and would likely cause minimal disturbance to birds. However, temporary displacement from preferred feeding, brood-rearing, or molting habitats could affect energy budgets of some birds, and incubating birds could be temporarily displaced from nests.

Watercraft. Several types of watercraft could be used during the summer and fall for transportation of equipment and supplies and for oil spill response training drills. Summer and fall barge traffic, which would transport equipment and supplies to staging areas along the coast and could temporarily displace molting and staging waterfowl, would likely occur in near shore and offshore waters of the planning area from mid-July through October. Displaced waterfowl would probably move to adjacent habitats or return to their original habitats after the barges passed through the area. It is well known (Avery et al 1980, Springer and Dailey 1980, Day et al. 2003) that birds may be attracted to sources of light with the potential for the bird to strike a structure (building, barge, tower etc.) resulting in the possibility of mortality. There are documented accounts of waterfowl and seabirds being attracted to and colliding with ships in various light conditions (Dick and Donaldson 1978). Eiders in particular are thought to be susceptible to collision with human-made structures because they fly low over the water while migrating, fly rapidly when migrating, and are attracted to lights (Day at al. 2003 and references contained within). However, there is a short window of time during the fall when the planning area is dark and birds are present, thus the potential for collisions between staging waterfowl and barges working in the planning area is low. Effects of barge traffic would vary in intensity depending on the timing, location and duration of the traffic in areas of high bird concentrations. Overall barge traffic in the Arctic Ocean is projected to increase due to the observed longer open water season and retreat of sea-ice in the arctic. Most of the area adjacent to the coastline would not be available to oil and gas leasing, and the potential for barge traffic to displace waterfowl under Alternative A would likely be lower than under alternatives B, C and D.

Oil spill response training activities using watercraft could be conducted on rivers and lakes several times during the summer open-water season. The vessels used would likely be small, maneuverable crafts, suitable for work in shallow waters and may include airboats and hovercrafts which are types of watercraft for which the impacts on north slope nesting, brood-rearing and molting birds is unknown. Spill response training activities would have the potential to disturb foraging, nesting, or brood-rearing waterfowl and other birds. Boat activity could cause alert postures, disruption of feeding behavior, and flight in waterfowl, shorebirds, and raptors (Burger 1986, Belanger and Bedard 1989, Steidl and Anthony 2000). Rodgers and

Smith (1995) and Rodgers and Schwikert (2001) determined the required set-back distances for minimizing the potential for boat disturbance to various bird groups. Suggested buffer zones around areas of activity ranged from 325 feet for shorebirds to 600 feet for wading birds. Establishing buffer zones around known areas of waterfowl and shorebird activity, during oil spill response training activities, or conducting these activities in areas not frequented by these birds or timed to not occur during critical nesting, brood-rearing and molt times, could help to reduce negative impacts to birds.

Habitat Losses and Alteration

Permanent Habitat Loss. Gravel mining and placement for the construction of oil field infrastructure would cause the loss of tundra-nesting bird habitat. During construction of oil field roads and pads, tundra covered by gravel, as well as tundra associated with gravel mine sites, would be lost as nesting, brood-rearing, and foraging habitat. This loss of habitat would continue through the duration of the operation of the proposed development, and would be permanent unless habitat restoration measures were successfully implemented after abandonment of the oil/gas field. Development scenarios indicate that at abandonment of the field, gravel may or may not be removed and that reclaimed or abandoned pads may be revegetated with native species or species that ultimately would be replaced by native vegetation or would be allowed to bed naturally. The potential long-term impacts associated with habitat loss could be minimized by locating gravel roads, pads, airstrips, and mine sites away from areas with high concentrations of tundra-nesting birds and areas that may be critical to species of special concern or species with declining populations. Under Alternative A, Lease Stipulation 39 would provide for setbacks from lakes in the Deep Water Lakes Area south of Teshekpuk Lake; permanent oil and gas facilities could be prohibited within these setbacks, to be determined on a case by case basis. Although this lease stipulation was designed primarily to protect fish habitat, it could also help to mitigate potential impacts to bird habitats.

Under Alternative A, it is estimated that there will be a need for five central processing facilities (90 acres each) in the planning area. In conjunction with these facilities there are other support structures, such as gravel production pads, gravel runways in-field gravel roads, several types of pipelines, and other associated structures, that will also cause surface disturbances. It is estimated that under Alternative A, there will be: 23 gravel production pads (10 acres each); 5 gravel runways (11 acres each); 230 miles of in-field gravel roads (7.75 acres/mile); 230 miles of three-phase produced fluids (oil, gas, water) gathering lines; 162 miles of sales oil pipelines; 5 pump stations (20 acres each); 2 staging bases (50 acres each); and 11 gravel pits (50 acres each). It is estimated that during the construction phase of these facilities that the total short term disturbance would be 4,679 acres. During the production phase it is estimated that the total long term disturbance would be 3,270 acres (Table 4.2-G).
Some birds that nest at sites covered by gravel would be displaced and may not be able to find suitable habitat for breeding. Others would likely move to adjacent areas to nest. Troy and Carpenter (1990) reported that at least some shorebirds displaced by winter gravel placement may nest in adjacent habitats in subsequent years, and Johnson et al. (2003b) reported that waterbirds nesting near the Alpine field that were displaced from nesting sites by gravel placement probably moved their nests to nearby adjacent habitats. In addition, there may be a functional loss of habitat in areas near roads and pads if development-related disturbances preclude birds from utilizing these habitats. Impacts related to habitat loss may be more severe for species that have specific habitat requirements or are species of special concern due to low population numbers, such as buff-breasted sandpipers that use dry, upland sites, should these sites be lost due to gravel placement. Under Alternative A, no permanent oil and gas facilities would be located in areas considered to be of high value to birds in the entire area surrounding

Teshekpuk Lake, including the Teshekpuk Lake Goose Molting Area (Lease Stipulations 21 and 24[k]). Therefore, the number of birds displaced from feeding, nesting, or molting/brood-rearing habitats due to gravel placement and mining activities under Alternative A could be lower than under Alternatives B, C and D. However, the potential effects of habitat loss under any alternative would depend on the location of the development, the types of habitat lost, and the level of bird use in the areas to be developed. Lease Stipulation 39 provides for setbacks for permanent oil and gas facilities along specified rivers and creeks to protect nesting raptors.

Temporary Habitat Loss. In addition to permanent habitat loss, temporary loss of habitat associated with gravel placement could occur on tundra adjacent to gravel structures, where accumulated snow from snow plowing activities or snowdrifts would become compacted and lead to a delayed snowmelt. Delayed snowmelt persisting into the nesting season could preclude tundra-nesting birds from nesting in those areas. Delayed snowmelt resulting from the construction and use of ice roads during winter activities could also cause temporary habitat loss. Ice-roads could also cause compaction of vegetation, thereby reducing the availability of cover for nesting birds in the ice-road footprint. Potential impacts to tundra nesting birds from ice-roads may be reduced by alternating ice-road routes annually and by avoiding routes near known areas of high bird concentration. Lease Stipulation 18 would require that ice roads be offset from year to year to minimize impacts to vegetation.

Water withdrawal from lakes during ice-road construction could lower the level of lakes and affect waterfowl and shorebirds that use adjacent habitats, particularly small islands and shoreline areas that are used for nesting by loons and waterfowl. Changes in the surface levels of lakes due to water withdrawal would be dependent on the amount of water withdrawn, the volume of the lake, and the recharge rate. Lease Stipulation 20 places restrictions on the amount of water that could be withdrawn from individual lakes. In the existing area of oil exploration and development in the vicinity of the Northeast Planning Area, pumped lakes have recharged in the spring at levels similar to unpumped lakes (Streever et al. 2001; URS 2001; Baker 2002). These observations are likely transferable to other areas that have a high concentration of lakes; however, areas with sparse lakes will have different watershed dynamics that will require additional study. In most cases, spring flooding during break-up would likely be sufficient to restore water levels (Rovansek et al. 1996). There is also potential for impacts to birds due to potential impacts to invertebrate food resources from varying winter water levels due to pumping or if recharge does not fully recharge pumped lakes.

Dust deposition can affect bird habitat by causing early snow melt and thus early green-up on tundra adjacent to roads and pads, which could attract waterfowl and shorebirds early in the season, when other areas are not yet snow free. Dust deposition could also increase thermokarst and soil pH, and reduce the photosynthetic capabilities of plants in areas adjacent to roads (Walker and Everett 1987; Auerbach et al. 1997). Traffic levels, air traffic (including helicopters), and wind can all influence the amount of dust that may be deposited adjacent to roads and pads. Troy (1988) reported higher densities of birds on lightly dusted sides of roads in the Prudhoe Bay oil field than on heavily dusted sides, although red-necked phalarope was an exception to this generality. Rodrigues (1992) also reported that red-necked phalarope nest densities were higher on tundra near abandoned gravel pads than in areas away from pads, and suggested that phalaropes may be attracted to areas of thermokarst near the edges of gravel pads.

The melting of ice roads could be delayed compared to surrounding tundra, causing impoundments of water. Impoundments created by ice roads or gravel structures could cause temporary or permanent flooding on adjacent tundra. Impoundments could be ephemeral,

drying up early during the summer, or they could become permanent water bodies that would persist from year to year (Walker et al. 1987a,b; Walker 1996). Tundra covered by impounded water could result in a loss of nesting habitat for some birds. However, impoundments could also create new feeding and brood-rearing habitat that would be beneficial to some bird species. Noel et al. (1996) reported that the areas occupied by impoundments in the Prudhoe Bay area generally supported higher waterfowl densities than the same areas did prior to development. Kertell (1993, 1994) reported few differences in invertebrate numbers and numbers of Pacific loons when comparing use of natural ponds and impoundments in the Prudhoe Bay area. He also reported that ducks were more abundant on impoundments than natural ponds, although this difference was not statistically significant. The formation of impoundments could be beneficial to some species associated with nesting and brood-rearing in association with water provided the water level in the impoundment does not drop below the level necessary for successful completion of the breeding cycle. Impoundments that flooded upland habitats could negatively impact species such as plovers and buff-breasted sandpiper that use dry upland habitats for nesting or as courtship displaying areas. The effects of impoundments could be minimized or eliminated with culverts to allow for adequate cross-drainage at gravel structures. However, culverts blocked by snow or ice could prolong the spring flooding period (Walker 1996).

Mortality. Bird mortality could result from road kills due to collisions with vehicular traffic. Within the TAPS, road kills were the greatest source of bird mortality, particularly along the Dalton Highway where dust shadows caused early green-up along the road that attracted birds (TAPS 2001). The primary groups affected were grouse and passerines. Although the number of birds killed was not quantified, the level of mortality was probably minor when compared to the size of local populations. Reduced speed limits along roads, particularly during periods of poor visibility, and during spring breakup when birds may be aggregated adjacent to roads, could help to reduce the potential for bird collisions with vehicles.

Some bird mortality could also result from collisions with structures such as elevated pipelines, buildings, drilling rigs, towers, power lines if suspended above ground, boats (including barges), or bridges. Birds are at risk of collisions with objects in their path, particularly when visibility is impaired during darkness or inclement weather (Weir 1976). Collisions seem to increase when objects are illuminated with constant diffuse light and the tendency for birds to be drawn to diffuse light appears to increase during foggy or rainy weather (USDOI BLM 1999b 1998). Many of the birds migrating to and from the planning area will likely encounter structures associated with oil exploration, development or production and these structures may pose collision risks to these birds. However, visibility is generally good during long summer daylight hours in the Arctic, and collision has apparently been only a minor source of bird mortality associated with the TAPS (TAPS 2001). Bird collisions with powerlines in the Prudhoe Bay oil field have also been reported (Anderson and Murphy 1988).

Some predators, such as ravens, gulls, Arctic fox, and bears, would be attracted to areas of human activity where anthropogenic sources of food and denning or nesting sites are present (Eberhardt et al. 1982, 1983a, b; Day 1998; Burgess 2000). The availability of anthropogenic food sources, particularly during the winter, could increase winter survival of Arctic foxes and contribute to increases in their population. Increased levels of predation due to elevated numbers of predators could in turn impact nesting and brood-rearing birds. Major negative impacts have occurred at the Howe Island goose colony in the Sagavanirktok Delta from predation by Arctic fox and grizzly bears (Johnson 2000a), and Arctic foxes and glaucous gulls are predators of common eider and brant eggs and young on the barrier islands (Noel et al. 2002). Arctic fox predation can also impact tundra nesting shorebirds and passerines (Day 1998,

Rodrigues 2002). In recent years, oil field operators have installed predator-proof dumpsters at camps and implemented new refuse handling techniques to minimize the attraction of predators to the landfill. In addition, oil field workers undergo training to make them aware of the problems associated with feeding wildlife. At the Alpine field, Johnson et al. (2003b) reported that except for the nesting of one pair of ravens, the numbers of predators and levels of predation after development did not increase in the area compared to pre-development levels. Lease Stipulations 1, 2, and 3 require proper disposal of refuse to avoid human-caused changes in predator populations.

There has been speculation that researchers conducting studies on avian nest density and success may inadvertently affect the results by attracting predators to nests and broods (Bart 1977, Strang 1980, Johnson 1984, Götmark 1992). Birds that are flushed from their nests during surveys may be more susceptible to nest predation than undisturbed birds. However, Vacca and Handel (1988) reported that covering eggs with down after incubating geese were flushed from nests essentially negated the effect of attracting predators during nest visits. Nonetheless, ongoing activities with repeated disturbance by researchers could cause some mortality to eggs and chicks of tundra nesting birds.

Effects of Abandonment and Rehabilitation

The impacts of abandonment and rehabilitation of oil fields on birds would be similar in many respects to those incurred by construction activity. Activities occurring in the winter would cause little disturbance or displacement, because most species would be absent from the area. Summer road and air traffic generated by abandonment and rehabilitation activities could cause disturbance, displacement, and mortality to birds that would be similar to, and at the same levels as that caused by traffic during construction and operations. If pads, roads, and airstrips were not revegetated, their value to birds would be lessened. If they were revegetated without removing the gravel, the habitat would not return to its current utility for most birds of the area. If gravel was removed, habitat similar to that currently existing in the area could be created and used by birds, though the precise mix of habitat types would likely not be the same as what prevailed at the time of disturbance. Foam insulating materials used in pad construction could be broken up in the course of removal. Fine particles of foam not removed from the environment could be ingested by some birds incidentally; depending on the material's toxicity and the amount ingested, ingestion of foam could cause sickness or mortality, though the number of birds harmed would likely be very small.

Effects of Spills

Crude oil spills could occur from pipelines, production and exploration pads, airstrips, roads and bridges. Spills that leave the pads and roadbeds could reach one or more of several habitat types, including wet and dry tundra, tundra ponds, lakes, flowing creeks and rivers, and potentially the adjacent nearshore Beaufort Sea. Spills could occur anytime during the year. Refined-oil spills could occur along ice roads, or from barges, helicopters, airplanes, gravel pad facilities, or trucks along the road system. Typical refined products spilled on the North Slope are aviation fuel, diesel fuel, engine lube oil, fuel oil, gasoline, grease, hydraulic oil, transformer oil, and transmission oil. Refined oil is most often spilled in very small volumes and is addressed here in conjunction with crude oil in small spill scenarios in order to address concerns about the potential chronic effects from numerous small spills. If seawater were used for enhancement of oil production, a saltwater spill could occur within the planning area. There is potential of negative impacts to birds from spills of all sizes and types occurring on land or on water (lakes, streams, rivers, marine waters). Spills of crude oil and refined products onto either

the tundra, freshwater or marine environments could affect birds through any and likely a complex interaction of the following: direct oiling of plumage, oiling of eggs, ingestion of oil, contamination of food resources, disturbance due to clean up efforts, and loss or alteration of habitat due to clean up activities. The extent of impacts to birds would depend upon the type and amount of materials spilled, the location of the spill, time of year, weather conditions, and the effectiveness of the response.

Oil spills or leaks onto tundra or marine habitats could negatively impact birds in numerous ways. Oil could come in contact with and adhere to birds' feathers, causing the feathers to lose their insulating capabilities and result in hypothermia (Patten et al. 1991). This effect would be particularly severe for birds that come in contact with water where feather integrity is necessary to maintain water repellency and buoyancy. Birds could also suffer toxic effects from ingestion of oil by consumption of food contaminated by an oil spill or from oil ingestion resulting from preening of oiled feathers (Hansen 1981). Oil contacting bird eggs could cause toxic effects to embryos (Patten and Patten 1979, Stickel and Dieter 1979). Oil could come in contact with eggs directly as a result of a spill, or indirectly from oiled feathers of incubating adults.

Topographical features could confine oil spills and leaks from pipelines located in terrestrial habitats. Spilled oil could also enter a lake or pond and be contained by the banks of these waterbodies. McDonald et al. (2002) developed a hypothetical spill scenario involving terrestrial and aquatic spills in the Prudhoe Bay area that covered 24 and 186 acres, respectively. Assuming a nest density of 0.6 nests per acre on 145 acres of tundra covered by a terrestrial oil spill, approximately 87 nests would be affected by the spill.

During spring flooding, an oil spill could spread to a much larger area, depending on the amount of oil spilled, surface topography, and the extent and duration of flooding. Oil entering a river or stream would have the potential to spread into delta or coastal areas, where impacts to waterfowl (including sensitive species such as yellow-billed and red-throated loons, eiders, long-tailed duck, and brant) could be more severe. The potential for an oil spill to enter major rivers or streams would be minimized by Lease Stipulation 39 that provides setbacks of ½ to 3 miles from specified rivers. However, if oil were spilled during the winter and not completely cleaned up or spilled during the spring breakup, free flowing water could carry oil to streams and rivers. Permanent oil and gas facilities, including gravel pads, roads, airstrips, and pipelines, would be prohibited within these setbacks, although pipelines could be permitted for water crossings in some of these areas. The large areas put aside as not available for leasing and no surface activity in Alternative A provide significant protections from the potential of an oil spill occurring in or reaching the high value habitats in the goose molting area.

In marine habitats, wind and currents would have the potential to spread spilled oil over a larger area than in terrestrial habitats; therefore, birds residing in marine habitats could be particularly susceptible to the negative impacts of an oil spill. The planning area does not contain offshore areas; however, a potential spill from an onshore or near shore source could spread to offshore marine areas, or a fuel barge or other support vessel could spill oil in offshore waters. A spill occurring during the summer breeding or spring or fall staging seasons would have a greater impact on birds than a spill occurring during the winter, when most birds are on wintering grounds. An oil spill spreading into offshore waters adjacent to the planning area, from Harrison Bay to Smith Bay could affect molting, brood-rearing and staging waterfowl, including yellow-billed and red-throated loons, long-tailed ducks, scoters, and eiders (Fischer et al. 2002). An oil spill in coastal zone habitats of the Colville River Delta, Harrison Bay, and Smith Bay which support thousands of post-breeding shorebirds, could affect large numbers of

birds. An onshore spill along the coastline could affect molting and brood-rearing brant and other geese and waterfowl, although very little coastline would be available for oil and gas leasing and development activities under Alternative A. Cleanup of spilled oil during ice-covered periods or periods of broken ice will be difficult, and lingering oil may be present. If oil is present it will be hazardous to birds migrating and staging in the spring. Lingering effects from a winter spill could impact returning birds during the following breeding season if clean-up activities did not adequately remove contaminants from bird habitats and food sources. In addition, oiled carcasses of dead birds washing up on beaches or shorelines could also be hazardous to scavenging birds such as gulls, golden eagle, gyrfalcon, and peregrine falcon that feed on these carcasses.

Spill response activities would disturb birds if they were present in the spill area. The extent of the disturbance would depend upon a variety of factors, including spill size and location, response actions, weather and season. Aircraft or overland vehicles would temporarily disturb birds present in the vicinity of the spill. Response to disturbance could last from a few minutes to a few hours to multiple days. Displacement of birds could occur on a temporal scale of a few days to the duration of the period that animals would be present in the spill area in that year. Depending on the size and timing of the spill birds may be affected by loss of life, reduced survival, reduced future breeding opportunities, loss of yearly nesting attempt, loss of brood or loss of body condition.

If an oil release from a pipeline, or a spill large enough to escape from a gravel facility pad were to occur, some tundra vegetation would become contaminated. For most spills, control and clean-up operations (ground traffic, air traffic, and personnel) at the spill site would frighten birds away from the spill and limit the likelihood that these animals would graze on the oiled vegetation. In most cases, onshore oil spills would not be expected to affect birds through ingestion of oiled vegetation. For large spills that are not immediately or successfully cleaned up, the potential for contamination would persist for a longer time and there would be a greater likelihood of animals being exposed to the oil. Cleanup success would likely vary depending upon the environment (see **section 4.3.5** regarding effects of oil on different types of vegetation). Habitat would be lost for use by birds during the spill, clean-up and some period after the clean-up while vegetation recovery is occurring. Over time, any remaining oil would gradually degrade. Although oiling of animals would be unlikely to remain a threat after clean-up efforts, some toxic products could remain for some time. Depending upon the spill environment, a portion of the oil could persist for five years (USDOI BLM and MMS 1998).

If seawater were used for enhancement of oil production, a saltwater spill could occur within the planning area. According to McKendrick (2000), brine spills kill plants on contact and increase soil salinity to the point that many species cannot survive. Unlike oil, salts are not biodegradable, and natural recovery occurs only after salts have leached from the soil. A spill would have effects on salt-intolerant vegetation near the seawater spill, but the amount of tundra habitat affected would likely be no more than a few acres. Thus, unless a seawater spill occurred in an area of high density foraging, forage availability for birds in the planning area would not likely be affected. Over the long term, mortality of vegetation in the area affected by the spill would make the area undesirable for grazing by birds until the vegetation recovered.

The assumed volume of small crude/refined oil spills over the life of the development in Northeast NPR-A under Alternative A is considered to be 2,778 bbl. This estimated small spills volume for Alternative A is considerably lower that the estimated small spills volume for Alternative B, C and D due to the following: 1) amount of infrastructure [length of pipeline (of all types), number of central processing facilities and production pads, miles of roads, etc. see

Table 4.2-E and 4.2-G], and 2) amount of area available for oil development and exclusion from leasing of particularly sensitive areas. Because of the relatively small volumes involved, management practices, and the substantial emphasis that is placed on oil-spill response plans and procedures, small crude and refined-oil spills associated with Alternative A would not likely have a measurable effect on birds at a population level in the planning area, although effects to individual birds could range from short-term disturbance to death. Many independent factors will determine the probability that birds will be negatively impacted by a small oil spill, including the quantity spilled, season, location (e.g. land versus water), and proximity to sensitive habitat. Impacts to birds from small crude/refined oil spills under Alternative A would have the least impact as compared to Alternative B, C, and D.

The assumed volume of large crude oil spills over the life of the development in Northeast NPR-A under Alternative A is considered to be 11,880 bbl over the course of an estimated 2.5 spill events. This estimated large spills volume for Alternative A is lower that the estimated large spills volume for Alternative B, C and D due to the total amount of infrastructure [length of pipeline (of all types), number of central processing facilities and production pads, miles of roads, etc. see Table 4.2-E and 4.2-G] expected to be in the area. Even with the protection of particularly sensitive areas (goose molting area), management practices, and the substantial emphasis that is placed on safe-guarding against an oil spill, oil-spill response plans and procedures, large crude oil spills associated with Alternative A could have a measurable effect on birds at a population level in the planning area, and the effects to individual birds could range from short-term disturbance to death. Impacts to birds on a population level could occur if oil from a large spill entered rivers, important molting or brood-rearing lakes, or marine areas during periods when large proportions of specific populations (e.g. brant, long-tailed ducks, eiders and shorebirds) were present. Many independent factors will determine the probability and extent to which birds will be negatively impacted by a large oil spill, including the quantity spilled, season, location (e.g. land versus water), and proximity to sensitive habitat. Impacts to birds from large crude/refined oil spills under Alternative A would have the least impact as compared to Alternatives B, C, and D.

Commercial Gas Development

Any effects on birds of natural gas development and production under Alternative A that are associated with previously constructed oil infrastructure, such as noise and visual disturbance from vehicles or construction activity, are expected to be temporary, nonlethal, and local, affecting few individuals. Resident ptarmigan, gyrfalcons, snowy owls and ravens may be present in the area during construction activities associated with gas development; however, the impacts to these species will be slight. Migrant bird species, which account for the vast majority of the avian species on the North Slope, will not be present during winter construction activities (ADNR, 2006b). Changes in vegetation community caused by burial of the pipeline could result in a loss of bird habitat. Any emergency repair of a buried pipeline that occurred in summer has the potential to disturb nesting, brood-rearing, feeding, staging or molting birds. Buried pipelines would not impact birds. Above ground pipelines could present a collision hazard to low-flying birds.

A natural gas well blowout occurring between May and October could affect birds that are nesting, rearing young, staging, or migrating. Some mortality could result from such an incident, although it is likely that a small number of individuals would be affected. A gas pipeline leak may also cause effects on birds through the presence of response personnel and equipment. Such impacts to waterfowl would be less likely in Alternative A than in the other

alternatives, because Alternative A would not make available for leasing or development the important bird habitat north and east of Teshekpuk Lake.

4.3.8.3 Effectiveness of Stipulations

Numerous lease stipulations were developed in the 1998 Northeast IAP/EIS ROD to effectively protect birds and their habitats within the planning area. These include Lease Stipulations (1 through 17) to ensure that solid, liquid, and hazardous wastes (including fuels) do not impact birds or their habitats, and to reduce the potential for garbage to attract animals that may prey upon birds to exploration and development sites. Lease Stipulation 20 protects bird habitat and food resources by limiting the withdrawal of water from rivers and streams during winter. Lease Stipulation 21 ensures that water withdrawals do not impact lakes, or lake habitats, used by molting geese, while Lease Stipulations 24(i&k) prohibits operations including seismic ground operations during spring and summer to prevent activity-related disturbance to geese during the nesting and molting period. Lease Stipulation 38 requires that all pipelines be constructed with the best technology for detecting corrosion and leaks. Lease Stipulation 41, which prohibits the construction of all permanent oil and gas facilities, roadways, airstrips, and pipelines within 500 feet of any active floodplain unless otherwise permitted by the AO, also establishes a buffer zone to protect bird habitat from oil spills. Disturbances caused by aircraft are controlled within the Goose Molting LUEA under Lease Stipulations 53 and 54. Wetlands used by shorebirds and other birds are given special protection (Lease Stipulation 46). In addition, there are numerous Lease Stipulations that regulate the types of activities that can occur near water bodies, including rivers and streams, types of equipment that can be used, and types of exploration and development activities that can be conducted in the planning area, to protect birds and their habitats.

4.3.8.4 Conclusion

Bird groups that could be affected by activities in the planning area include loons, waterfowl, shorebirds, raptors, passerines, seabirds, and ptarmigan. Most species in these groups migrate to wintering areas located outside of the planning area and would not be directly affected by winter exploration or construction activities, although their habitats could be affected. A few species, such as ptarmigan, gyrfalcon, and snowy owl, could remain in the planning area during the winter and could be temporarily displaced from preferred feeding or hunting habitats by winter exploration or construction activities. During the exploration period, summer fixed-wing or helicopter aircraft activity could result in disturbance to tundra-nesting birds, causing temporary or permanent displacement from preferred feeding, nesting, or brood-rearing habitats in localized areas near areas of activity. Aircraft support for summer research camps or for cleanup of abandoned sites in the planning area could also impact birds near these sites. Most aircraft disturbance during construction and development would be confined to the area within approximately 2,300 feet of the site, and little disturbance would be likely beyond 6,500 feet. Predators attracted to areas of human activity could also impact tundra-nesting birds by causing depredation of eggs and young; however, lease stipulations designed to eliminate attraction of predators to camps or equipment maintenance sites would help to mitigate potential increases in predators. Effectiveness of lease stipulations are unknown at this time but are presumed to be effective. Although lease stipulations promote practices to discourage bird nesting at facility sites, it may be difficult to prevent ravens from nesting on buildings or other structures.

Activities related to oil development and production, such as vehicle, aircraft, pedestrian and boat traffic, summer tundra travel, routine maintenance activities, heavy equipment use,

facility noise, and oil spill clean-up activities, could cause disturbances that would affect tundra-nesting birds. Most vehicle disturbance would likely be confined to areas within 160 to 685 feet of roads and pads. Disturbance related to aircraft activity would likely be confined to areas within 2,300 feet of landing strips, when stipulations requiring minimum flight altitudes are followed, and little disturbance would be likely beyond 6,500 feet. Pedestrian traffic would be likely to cause more disturbance than other activities, as birds may acclimate to routine aircraft or vehicular activity and to equipment or facility noise. Barges and other vessels could temporarily displace loons and waterfowl from preferred offshore and near shore feeding, staging, brood-rearing, or molting areas. However, birds would likely move back to preferred areas after vessels passed through the area or continue to use adjacent areas, and the effects of occasional vessel traffic would likely be minimal. Effects may change if vessel traffic becomes more that occasional. Smaller watercraft on rivers or lakes used during oil spill clean-up or training exercises also cause disturbance to tundra-nesting birds. Surveys conducted prior to development would help identify areas with low levels of bird use that would be suitable for oil spill training activities and cause the least impact to tundra-nesting birds. Conducting activities during time periods of low bird activity (i.e. post fledging) may also reduce the potential impacts of spill exercises.

Permanent habitat loss would result from gravel placement for roads and pads, and at gravel mine sites. Temporary habitat loss or alteration could also occur in areas adjacent to gravel roads due to snow and/or dust deposition, thermokarst, and the formation of impoundments. Some types of habitat alteration, such as the formation of impoundments, could be beneficial to some species while having a negative impact on others. Withdrawal of water from source lakes during winter construction of ice-roads could impact tundra-nesting birds if water levels or prey availability in source lakes were affected. Lake surveys conducted prior to water withdrawal, State of Alaska regulations limiting the amount of water that may be withdrawn from specific lakes, and the ability of lakes to naturally recharge, would likely eliminate any potential negative impacts related to water withdrawal.

Bird mortality could result from collisions with vehicular or vessel traffic, or collisions with towers, buildings, pipelines, powerlines suspended from pipelines, bridges, or other facilities. However, it is expected that collisions would only be a minor source of bird mortality. Bird mortality could also result from the attraction of predators to areas of human activity. Adherence to lease stipulations that require proper disposal of garbage to avoid human-caused changes in predator populations would likely minimize potential impacts to tundra-nesting birds from increased predation pressure. Additional bird mortality could result from subsistence hunting activities if oil field infrastructure were to provide hunters with access to previously inaccessible areas. Typically, however, subsistence users tend to hunt and fish away from oil and gas infrastructure (see **section 4.3.12.3**).

An oil spill could impact tundra-nesting birds on terrestrial or marine habitats. Potential impacts to tundra-nesting birds would depend on the location and size of the spill and on the time of year. Due to the actions of wind and currents, a marine spill would have a greater potential to spread to a large area than a terrestrial spill. A marine spill could impact thousands of molting and brood-rearing waterfowl and loons.

The expected number of fields and the level of development under Alternative A would be lower than under the other alternatives. Therefore, the potential effects of disturbance, habitat loss and alteration, and bird mortality due to development would also likely be lower under Alternative A than the other alternatives.

In general, impacts to birds from non-oil and gas activities, and from oil and gas activities, would be additive. Impacts to birds from exploration and development activities would also be additive. Potential impacts from seismic activity would be the same for all alternatives as it is expected that 3 2-D and 2 3-D surveys would be conducted under each alternative in the foreseeable future. During the exploration and discovery phases Alternatives B, C and D would cause 13, 39 and 29%, respectively, greater short term surface disturbance, compared to Alternative A, due to the number of exploration and delineation wells that would be drilled (Table 4.2-G). During the development and production phases Alternatives B, C and D would cause 18, 40 and 22%, respectively, greater short term surface disturbance, compared to Alternative A, and 14, 42, and 33%, respectively, greater long term surface disturbance due amount of infrastructure needed (Table 4.2-G).

4.3.8.5 Potential New Mitigation Measures

1) Colville River Special Area

<u>Potential Mitigation Measure (New Stipulation)</u>
a. Removal of sand and/or gravel from cliffs shall be prohibited.

b. Any extraction of sand and/or gravel from an active river or stream channel shall be prohibited unless preceded by a hydrological study that indicates no potential impact by the action to the integrity of the river bluffs.

Potential Benefits and Residual/Unavoidable Impacts

Prohibiting the removal of sand and gravel from cliffs in the Colville River Special Area will enhance existing protections to raptor nest sites in this Special Area. Preservation of cliffs would allow for the continued expansion of the breeding population of cliff nesting raptors in the Colville River Special Area by providing potential nest sites for all species of cliff nesting raptors. Prohibition of removal of sand and/or gravel from an active river or stream channel will negate to potential for subsequent erosion of downstream cliffs. Nest sites for cliff nesting raptors are potentially population limiting and destruction of cliff nest sites caused by sand/gravel mining would accelerate the existing natural erosion of cliffs in the Special Area.

Paleontological resources may indirectly benefit from this measure by providing protection to the substrates that may contain these undiscovered resources. Water quality downstream of a gravel mining operation that occurs in the river bed would benefit from the prohibition of mining in the stream bed and the subsequent erosion of downstream cliffs. Visual resources and recreation would benefit from this measure by virtue of an environment unchanged by human cause gravel mining and subsequent erosion of downstream cliffs.

Construction costs may increase in some situations if gravel needs to be transported to the construction site instead of mining of gravel near the site.

2) Raptor Protection

<u>Potential Mitigation Measure (New Stipulation)</u>
Comply with the most up to date suggested practices for raptor protection on power lines. Refer to the publication: <u>Suggested Practices for Avian Protection on Power Lines: The State of the Art in 2006</u> Item #40-06-01-008 funded and produced by the Avian Power Line Interaction Committee and the California Energy Commission.

Potential Benefits and Residual/Unavoidable Impacts

Requiring all power lines and poles to be designed and constructed in a manner which reflects raptor safe configurations will prevent death of raptors by electrocution.

Additional cost may be incurred by the developer in order to provide raptor safe power lines and poles.

4.3.9 Mammals

4.3.9-a Terrestrial Mammals

Terrestrial mammals that could be affected under Alternative A include species such as caribou from the TLH, CAH, and WAH, moose, muskox, grizzly bear, wolf, wolverine, red fox, Arctic fox, and small mammals (e.g., Arctic ground squirrel, ermine, least weasel, lemming, voles, and shrews).

4.3.9-a.1 Activities Not Associated With Oil and Gas Exploration and Development

Activities such as resources inventories, aerial surveys, and research camps would have short-term effects on terrestrial mammals.

Effects of Disturbances

Non-oil and gas activities that could disturb terrestrial mammals include aerial surveys and ground activities such as resource inventories, paleontological excavations, research camps, recreational camps, and overland moves. Overland moves would occur during the winter on frozen tundra, ice roads, or stable shorefast ice. Other activities would occur from summer to early autumn (June-September). Potential causes of disturbance to terrestrial mammals from inventory activities and overland moves would be helicopter traffic (1 to 2 round trips per day for 3 to 6 weeks per survey party), fixed-wing aircraft traffic (2 trips per week per party), surface-vehicular traffic on ice roads, and humans on foot. Caribou have been shown to exhibit panic or violent flight reactions to aircraft flying at elevations of approximately 160 feet and to exhibit strong escape responses (animals trotting or running from aircraft) to aircraft flying at 150 to 1,000 feet (Calef et al. 1976). These documented reactions were responses to aircraft that circled and repeatedly flew over caribou groups. While aircraft associated with aerial wildlife surveys might circle or fly over a group of caribou more than once, aircraft associated with support of survey and inventory camps would pass over caribou only once on any given flight to or from a camp. Recreational and research camps could result in short-term displacement (24 hours to several weeks) or harassment of terrestrial mammals and minor disturbance to the vegetation and soil due to trampling. Potential habitat disturbance from large camps would be reduced by using existing sites whenever possible.

In some cases, recreational camps could attract grizzly bears and Arctic and red foxes, resulting in the shooting of bears that learn to associate humans with food sources, or the shooting of foxes that present a risk to personnel safety because of rabies. Any such losses would be minor to the bear or fox populations on the North Slope, but would contribute to cumulative effects.

Small rodents, such as lemmings and voles, and their predators, such as ermines and least weasels, would likely be affected locally, with direct mortality and minor loss of habitat possibly resulting from paleontological excavations and by overland moves.

Effects of Spills

Very small fuel spills (probably less than 1 bbl) could occur in association with resource-inventory surveys, recreational activities, and overland moves. These spills would likely involve aviation fuel and other light-fraction hydrocarbon fuels that would evaporate and disperse rapidly in the environment with only a local effect on vegetation. Under current BLM regulations, fuel spills would be cleaned up immediately, if possible. However, it is not clear how many spills go unreported. Small spills associated with non-oil and gas activities would not be expected to have a substantial effect on terrestrial mammal populations in the planning area, although they could greatly affect individual animals.

4.3.9-a.2 Oil and Gas Exploration and Development Activities

Under Alternative A, approximately 87% of the planning area would be available for leasing and possible development. The development scenario under Alternative A assumes that five CPFs along with associated with production pads and other facilities would be developed south of the Teshekpuk Lake area. Impacts to terrestrial mammals are expected to come from motor vehicle, foot, and aircraft traffic; seismic operations; oil spills; gravel mining; and construction. The primary impacts to terrestrial mammals would likely be those associated with disturbance and habitat alteration, and potentially could include increased energy expenditure, decreased body reserves and reduced fecundity.

Effects of Disturbances

Seismic. Impacts to habitat used by terrestrial mammals would be minor, as most seismic activities would occur during the winter on frozen tundra or ice. Potential causes of disturbance to terrestrial mammals from seismic activities would include surface vehicular traffic on frozen tundra or ice and fixed-wing aircraft traffic. In most cases, these activities would cause short-term displacements of and/or disturbance to terrestrial mammals. Where 3-D seismic exploration survey lines were located only 500 to 2,000 feet apart, localized displacement of terrestrial mammals could last for several days or lead to complete abandonment of localized habitat.

Effects on caribou and moose would be similar in type to those discussed under non-oil and gas activities, but would likely be greater in extent, frequency, and duration. During winter, moose move to the riparian areas of large rivers; in the planning area they are most likely to concentrate along the Colville River. The TLH caribou are present throughout much of the planning area during the winter, with large numbers often congregating in the central and eastern portions of the planning Area. Therefore, caribou would likely be encountered during seismic surveys in the planning area. It is possible that displacement of caribou by seismic exploration activities during winter could have a negative effect on their energy balance (intake vs. expenditure). Because these animals are mobile and the operation would be short-term (passage of vehicles) in duration, it is not anticipated that any lasting adverse impacts to caribou would result under most circumstances. However, this assumption has not been scientifically tested and conditions for winter survival vary from year to year. It is possible that this disturbance could have an additive effect on natural winter mortality and could disproportionately impact young of the year and pregnant cows.

Previous studies of the effects of oil and gas exploration on muskox in Alaska and Canada focused on disturbances associated with winter seismic operations. Some muskox reacted to seismic activities at distances up to 2½ miles from the operations; however, reactions were highly variable among individuals (Reynolds and LaPlant 1985). Responses varied from no response to becoming alert, forming defense formations, or running away (Winters and Shideler 1990). The movements of muskox away from the seismic operations did not exceed 3 miles and had no apparent effect on muskox distribution (Reynolds and LaPlant 1986). Unlike caribou, muskox are not able to travel and dig through snow easily. In the winter, they search out sites with shallow snow, and greatly reduce movements and activity to conserve energy (USDOI USFWS 1999). Muskox survive the winter by using stored body fat and reducing movement to compensate for low forage intake (Dau 2001). Because of this strategy, muskox may be even more susceptible to disturbances during the winter. It is possible that repeated disturbances of the same animals during winter could result in increased energetic costs that could increase mortality rates. Depending upon the location of the seismic exploration, impacts on muskox would be non-existent to minor. Mixed-sex groups of muskox have occurred in the planning area, but there are currently no reports of year-round occupancy. However, potential habitat occurs throughout, and populations outside of the planning area are gradually expanding their range. Most likely, seismic operations would be expected to encounter no more than one to a few bulls. Breeding groups would more likely be affected, if at all, by seismic crews accessing the planning area from overland routes from the Kuparuk River area.

Exploration activities and human presence pose potentially serious disturbances to denning bears. In one study, seismic activities within 1.2 miles of a grizzly bear den caused changes in heart rate and movement of the female bear and cubs (Reynolds et al. 1986). The investigators suggested that seismic testing activities within about 600 feet of a den may cause abandonment of the den. Under Alternative A, Lease Stipulation 75 prohibits exploration activities within ½ mile of occupied grizzly bear dens. If den locations were known in the areas in which seismic work occurred, impacts to hibernating bears would be reduced. Overall, it is expected that impacts to bears would be minor, since the level of proposed seismic work is low. In addition, the area of highest potential for oil is the lowest density bear habitat (the highest bear density is located in the extreme southern portion of the planning area).

Seismic camps could result in localized disturbance and/or displacement of terrestrial mammals for up to a few days. Bears and foxes could also be attracted to camps, and in rare instances mortality could result. Since seismic camps generally move at least once a week and proper handling of wastes would be regulated by lease stipulations, the potential for bears or foxes to be attracted to human food sources would be minor. In addition, most seismic activity would occur when bears were hibernating.

The potential effects of oil and gas activities on wolverines would include disturbance from air and surface-vehicle traffic, and increased human presence. Wolverines are considered a shy and secretive species that is present at very low densities and may be sensitive to disturbance. Winter seismic activities in the Pik Dunes area south of Teshekpuk Lake are known to have caused the displacement of a wolverine from its den (Brower 1997 in USDOI BLM 1997). Wolverines have been sighted to the west of Teshekpuk Lake, along the Colville, Kikiakrorak, Kogosukruk rivers, and Judy and Fish creeks.

Small rodents (arctic ground squirrels, lemmings, voles, etc.) could be locally affected through direct mortality and by minor loss of habitat from overland traffic associated with seismic

operations. Their predators, such as short-tailed weasels, could be indirectly affected in local areas due to a reduction in prey. These losses would likely be minor at the population level.

The use of airguns for seismic work in Teshekpuk Lake during the summer, assumed to be unlikely under Alternative A, would probably cause only temporary displacement of terrestrial mammals near the lake. Displacement would occur primarily from the support activity associated with the surveys, such as helicopter flights to bring equipment to the lake. Once surveys were finished and the sources of disturbance had left the area, mammals would likely move back into the area around the lake.

Exploratory Drilling. Impacts to terrestrial mammals from exploratory drilling would be similar to those caused by seismic activity, though affecting a smaller area and lasting longer at one location. Habitat impacts would be negligible, as exploratory drilling would occur during the winter on frozen tundra, packed snow roads, and ice roads, and would affect a very small proportion of the total area.

Potential causes of disturbance to terrestrial mammals from exploratory drilling include surface vehicular traffic, humans on foot, fixed-wing aircraft traffic and the noise of the drill rig itself. These activities may cause short-term (a few minutes to 1 hour) displacements of and disturbance to terrestrial mammals, or they may cause abandonment of the local area for the remainder of the winter. Camps at drill sites could result in localized disturbance and displacement of terrestrial mammals for several weeks to months.

Exploratory drilling operations and ice roads would traverse TLH caribou wintering areas and could encounter some wintering caribou from the WAH, although most WAH caribou winter a considerable distance to the south of the planning area (Dau 2005). Any caribou in the immediate vicinity of the activity would be disturbed, possibly having a negative effect on their energy balance, hormonal status, and potentially calving success due to prolonged stress. Because these animals are mobile and the operation would be temporary, it is not expected that there would be any long-lasting effects on caribou. However, as with affects of disturbance by seismic operations, this assumption has not been tested and conditions for winter survival vary from year to year. It is possible that this disturbance could have an additive effect on natural winter mortality.

The winter distribution of muskox and moose is such that exploratory drilling activities would be unlikely to have any impacts on these species unless they occurred near riparian areas, such as the Colville River. Under such a circumstance, impacts would likely include short-term displacement or disturbance of animals, as described above, but may result in abandonment of winter habitat and negative effects on energy balance. Impacts to Arctic fox, grizzly bear, and wolverine would be similar to impacts from seismic activities, but would be more frequent and/or longer in duration. There would be a greater potential for foxes to be attracted or habituated to camps associated with drill sites, as they would be in place for one to two months, rather than a week or less. Small rodents could be locally affected due to direct mortality and minor loss of habitat from snow compaction or ice road construction. However, these losses should be negligible at the population level.

Oil Development. The primary effects of oil development on terrestrial mammals would result from the construction of facilities, such as roads and pipelines; motor vehicle traffic within the oil field(s) and on connecting roads; foot traffic near facilities and camps; aircraft traffic; crude-oil and fuel spills contaminating tundra, stream, and coastal habitats; and habitat alteration associated with gravel mining and construction.

Caribou

Although much of the construction associated with oil development would occur primarily during winter, caribou are often present in the planning area during that season. Operation of developments would bring year-round facilities and activities within caribou summer range. Caribou could be disturbed by traffic, humans on foot, and low-flying aircraft (Calef et al. 1976; Horejsi 1981; Shideler 1986; Tyler 1991; Murphy and Lawhead 2000). The response of caribou to disturbance would be highly variable, ranging from no reaction to violent escape reactions depending on: distance from human activity; speed of the approaching disturbance source; frequency of disturbance; sex, age, and physiological condition of the animals; size of the caribou group; and season, terrain, and weather. Caribou cow and calf groups appear to be the most sensitive to traffic, especially in early summer during and immediately after calving, while bulls appear to be least sensitive all year. Tolerance to aircraft, ground vehicle traffic, and other human activities has been reported in several studies of caribou and other hoofed-mammal populations in North America (Johnson and Todd 1977; Davis et al. 1980). It appears that caribou can habituate to structures, noise, and odors, but habituate slowly or not at all to humans on foot or large moving objects such as vehicles (Murphy and Lawhead 2000). Most of the caribou in the planning area are from the TLH and WAH caribou herds, however, and have had less exposure to human activities and are less likely to be tolerant of disturbances than animals habituated to activities at Prudhoe Bay.

Displacement of the CAH caribou from a portion of the calving range near the Prudhoe Bay and Milne Point facilities has been documented (Cameron et al. 1981, 1983, 1992). In the Kuparuk-Milne Point area, the relative distribution of calving has shifted away from development facilities (Lawhead et al. 1997; Wolf 2000). Cameron et al. (2002) evaluated changes in the distribution of calving CAH caribou associated with the Kuparuk-Milne Point area. Before construction of a road system to Milne Point, caribou were found in a single, more or less continuous concentration, roughly centered where the road was later built. After construction of the road, a bimodal distribution with separate concentrations of animals east and west of the road was apparent. Ground observations of caribou within the Kuparuk area from 1978 to 1990 indicated that caribou increasingly avoided zones of intense activity, especially during the calving period (Smith et. al. 1994). Lawhead et al. (2004) reported that maternal caribou with calves were displaced from areas near both the Tarn and Meltwater roads during calving and up to two weeks post calving. Very few calves were observed within 1.2 miles of either road during the calving period and densities appeared to be reduced as far away as 2.4 miles. Traffic convoying on the Meltwater road was not effective at reducing calving displacement to less than 1.2 to 2.4 miles, or reducing the disturbance reactions of caribou within 1,640 feet of the road. Data analyzed by Cameron et al. (2002) suggested that having roads too closely spaced would displace calving activity within the oil field complex. Other studies (Roby 1978; Cameron et al. 1981, 1983, 1992; Pollard and Ballard 1993) and literature reviews (Cronin et al. 1994, 1998) indicate some seasonal avoidance of habitats within three miles of existing Prudhoe Bay area facilities by cows and calves during calving and early post-calving periods (May through June).

The WAH and CAH caribou core calving ranges lie outside of the planning area, while the TLH caribou calving area is concentrated in the northern section of the planning area near Teshekpuk Lake. Under Alternative A, no permanent oil and gas surface facilities would be permitted in the Teshekpuk Lake Surface Protection Area, which is a subset of the Teshekpuk Lake Special Area. Exploratory or delineation wells would not be allowed in this area; however, ice roads, seismic activities, winter overland moves, and other nonpermanent activities could be authorized. Under such conditions, development under the Alternative A would have the potential to affect only that smaller portion of core calving habitat that lies southeast of the

Teshekpuk Lake Surface Protection Area. On-site development in this area could affect caribou movements or cause displacement of calving caribou. This may result in reduced use or the loss of some core calving habitat, which could in turn affect TLH productivity. Although populations level effects for the CAH following displacement from portions of its calving range have not been demonstrated conclusively (Cronin et al. 1998), a recent study of CAH productivity in the oil fields suggests that habitat quality in the calving area in one year may affect calf size at birth in the following year (Arthur and Del Vecchio 2006). Calf size at birth in turn influences calf size at the end of the first summer, which has consequences for survival through the following winter.

In some years, 5 to 10% of the WAH caribou may winter on the North Slope. Depending upon the location of oil development infrastructure, movement of both TLH and WAH caribou from winter range to calving grounds could be disrupted by oil development. The level of effect would depend upon the level of development. An appropriately elevated pipeline with no associated road would have little effect on movement between winter habitat and calving grounds (Lawhead et al. 2006). A road and associated traffic would have a greater impact. Pregnant caribou could be delayed in reaching the calving grounds because of delays in crossing roads or attempts to detour around roads or oil fields. Calving en route to calving grounds could result in reduced calf survival (Carroll et al. 2005). One issue arising from oil field development is the ability of caribou to move freely through the oil fields to insect-relief habitats. Caribou under extreme insect harassment initially move rapidly to insect-relief habitat. For the TLH caribou, this is often coastal areas outside of the planning area from west of Barrow to Smith Bay, and more importantly to the north and east of Teshekpuk Lake (within the planning area), predominately in the Teshekpuk Lake Special Area where permanent development would be prohibited under Alternative A. After reaching these habitats, caribou often continue to move rapidly and may cover long distances. Caribou generally react less to disturbance when under the stress of extreme insect harassment. The stress of human disturbances at this time may be additive to that caused by insect harassment. When insect harassment abates, caribou drift inland to better foraging areas. At this time, they are more reactive to disturbance and infrastructure and activities in oil fields or roads between oil fields could delay or alter movements of caribou from coastal insect-relief areas to foraging habitat further inland. Impaired movements between insect-relief habitat and inland foraging areas could reduce food intake and slow rates of cow and calf weight gain (Smith 1996). The probability of producing a calf is directly related to body weight and fat content of females during the previous autumn (Cameron et al. 2000). Since reproductive success of caribou is highly correlated with nutritional status (Cameron et al. 2002), there could be reproductive consequences from extensive disruption of caribou during the insect-relief season.

Cameron et al. (1995) noted that reports of insect-harassed caribou aggregations along the Beaufort Sea Coast and completely traversing the Prudhoe Bay complex, as reported in the 1970s, had become rare. An analysis of the distribution of radio-collared female CAH caribou from 1980 to 1993 suggested that caribou use of the oil field region at Prudhoe Bay had declined considerably from that observed in the 1970s (Cameron et al. 2002). However, the Prudhoe Bay field was not designed to facilitate caribou movement. It is complex and has many older pipelines that are less than five feet above the ground. Movement of insect-harassed caribou through the Kuparuk oil field has been examined in several studies (Johnson and Lawhead 1989; Lawhead et al. 1994; Smith et al. 1994). In the Kuparuk oil field where all pipelines are elevated a minimum of five feet above ground, mosquito-harassed caribou were able to pass through the field on their way to and from insect-relief habitat, although they typically detoured around drill pads and were often delayed up to several hours at road crossings. Smith et al. (1994) monitored caribou movement in relation to roads and increasing development in the

Kuparuk Area from 1978 to 1990. They found that groups of mosquito-harassed caribou were deterred from crossing roads with higher levels of vehicular traffic. Over the 12 years of the study, a change in access to the oil field area by insect-harassed caribou occurred. During the early years of construction, large insect-harassed groups of caribou approached the road from the middle section. By the end of the study, most large groups were observed at the extremes of the road transect, indicating that caribou might have been avoiding the core areas of industrial activity.

Development in the TLH caribou insect-relief habitat would be unlikely under Alternative A, since the majority of the insect-relief habitat is covered by the Teshekpuk Lake Surface Protection Area. When mosquito numbers decline and oestrid fly harassment increases in mid-July, the large aggregations of caribou generally disperse into smaller groups of animals seeking insect-relief habitats. These insect-relief habitats include a variety of unvegetated and elevated sites. Coastal areas apparently provide little relief from fly harassment (Ballard et al. 2000). Gravel pads and roads are sometimes used as fly-relief habitat by caribou (Johnson and Lawhead 1989; Pollard et al. 1996b). Oestrid flies are less common in shade than in sunlit areas (Pollard et al. 1996a), and caribou sometimes use the shade of elevated pipelines and buildings to escape from flies (Murphy and Lawhead 2000). Caribou are more aggregated at this time than during the fall and winter, and may move long distances when insect harassment occurs. At this time, oil field facilities and roads that temporarily delay movement of animals back to foraging habitats may negatively affect caribou movements. In the planning area, the majority of insect-relief habitat during the oestrid fly season is located around Teshekpuk Lake, although caribou tend to be more dispersed than they are during the mosquito season. Most oestrid fly relief habitat is located within the Teshekpuk Lake Surface Protection Area, and would not be affected under Alternative A. However, caribou do range further south in search of relief and do enter areas where development is possible.

Curatolo and Murphy (1986) evaluated the ability of caribou to cross roads and pipelines. They concluded that crossing success was reduced where pipelines were adjacent to heavily traveled roads (greater than 15 vehicles per hour). Isolated pipelines or roads had lesser effects on crossing success. Groups did eventually cross the roads and move through the oil field. For caribou in the Prudhoe Bay and Kuparuk oil fields and pipeline-road corridors, the greatest human-caused influence on behavior and movement is vehicle traffic (particularly high traffic levels, such as 40 to 60 vehicles per hour, or traffic levels of greater than 15 vehicles per hour) within the pipeline-road corridors (Murphy and Curatolo 1984, Lawhead and Flint 1993). Caribou are hesitant to cross the Dalton Highway and other roads on the oil fields because of the traffic (Lampe 1997 in USDOI BLM 1997). A decline in the frequency with which caribou cross pipeline corridors is attributed to high traffic levels on the adjacent road (Curatolo 1984). Caribou generally hesitate before crossing under an elevated pipeline, and may be delayed in crossing a pipeline and road for several minutes or hours during periods of heavy road traffic; however, successful crossings do occur. Caribou have returned to areas of previous disturbance after construction was complete in other development areas (Hill 1984, Northcott 1984).

A pipeline from an oil field(s) in the northern and central planning area would connect to the TAPS through facilities at the Kuparuk oil field, while an oil field in the extreme south of the planning area could connect to TAPS by a southern route. Any pipelines would be constructed during winter using ice roads, and no permanent road would be built. During construction, air traffic would include several flights per day, which could temporarily disturb some caribou within about a mile of the pipeline. It is expected that disturbance effects on caribou would be short term, interference with their movements would be temporary (a few minutes to less than a few days), and they eventually would cross the pipeline area. Also, disturbance reactions

would diminish after construction was completed. Disturbance of important riparian areas would be avoided. Oil field facilities (other than pipeline) would not be located within one mile of major stream drainages.

The mere physical presence of a pipeline would probably have a minimal effect on the behavior, movement, or distribution of caribou, except perhaps when heavy snowfall prevented some animals from crossing under or over the pipeline. During the winter, caribou movements could be blocked or interrupted along the elevated (5-foot) pipelines by snow drifting under the pipeline (Nukapigak 1997 in USDOI BLM 1997). Such an effect should be temporary and localized, however, with the caribou moving across the corridors at locations with shallower snow. Construction of additional pipelines from the Northwest NPR-A to the Kuparuk area would add to the cumulative effect of development on TLH and CAH caribou. Construction of a pump station in the NPR-A would result in the loss of up to 40 acres of tundra habitat and the temporary displacement or disturbance of caribou during construction.

Development of an oil field(s) could result in impacts to wintering TLH caribou; WAH caribou are unlikely to be encountered during winter since most winter south of the Brooks Range. Depending on the location of the development, some TLH caribou migration movements could be temporarily disrupted or diverted by air and surface traffic along pipelines and roads within the oil field. Wintering animals could also be temporarily disturbed or avoid the development area. Repeated disturbance of the same animals during the winter could have negative impacts on the energy balance of individual animals which might result in lowered calving success or even increased winter mortality.

Development of oil fields would require large amounts of gravel (up to five million cubic yards). Gravel is a scarce resource in the NPR-A, and if local sources of gravel were not available, alternative strategies could be used, including barging construction materials to coastal staging areas for later transit over ice roads, processing bedrock for construction materials, using year-round ice pads, or reusing gravel from previous Husky drill sites. Gravel extraction (outside of the planning area), hauling of the gravel on ice roads (into the planning area), and deposition of gravel in the lease areas would occur in winter when caribou are less mobile and often present in large, loose aggregations. These activities could result in local disturbance or displacement of some animals, but would not likely affect the overall distribution of caribou. The loss of relatively small areas of tundra habitat to gravel pads, roads, and other alterations generally has not had major effects on the CAH caribou, and would likely have a minimal impact on the TLH and WAH caribou.

Under Alternative A, some terrestrial mammals could be affected by offshore drilling from an ice island, and subsequent oil development on the coast of the planning area in Harrison Bay, in a small area south of Atigaru Point. This area is used by TLH caribou as insect-relief habitat during the mosquito season and during the oestrid fly season. Barging of supplies could also occur in this area but is not expected to have a substantial impact on terrestrial mammals. Noise and disturbance from these activities would be local and are not likely to affect terrestrial mammal populations.

<u>Moose</u>

Moose occur in low densities in the planning area during the summer and are concentrated in major drainages at the southern edge of the planning area in the winter. Unless an oil field were to be developed in the extreme south of the planning area near the Colville River, development would be unlikely to impact moose. A number of studies show that the TAPS has

no major effect on moose movements and habitat use near the pipeline (Sopuck and Vernam 1984, 1986; Eide et al. 1986). In one study, 94% of moose successfully crossed the pipeline corridor, and moose distribution was independent of distance from the pipeline (Sopuck and Vernam 1986). However, moose preferred to cross pipelines elevated above five feet (Sopuck and Vernam 1984). Under Alternative A, in-field pipelines and a crude oil pipeline (elevated five feet) connecting with the TAPS would not be expected to affect moose habitat use and movements regardless of the location of the field(s). Air and surface traffic could also disturb moose, but the number of animals affected would likely be small, and no impacts to the population would be anticipated; any air or surface traffic disturbance should be of short duration.

If gravel were mined from riverbeds in the planning area, a temporary displacement and disturbance of moose could occur. Borrow pit operations could destroy or degrade up to 550 acres of moose habitat.

Muskox

Potential effects of oil and gas development activities on muskoxen include displacement and disturbance of individual animals, direct habitat loss from gravel mining in river floodplains and at oil field facilities, and indirect habitat loss through reduced access caused by physical or behavioral barriers created by roads, pipelines, and other facilities (Garner and Reynolds 1986; Clough et al. 1987). Muskox may be more exposed to oil exploration and development than caribou, because they tend to remain year-round in the same habitat area (Jingfors 1982); conversely, muskoxen may be able to habituate to these activities because of this year-round exposure. Muskoxen have been exposed to the TAPS, the Dalton Highway, and the Kuparuk and Alpine oil fields with the expansion of their range west from the Arctic National Wildlife Refuge and the Kavik River. If populations expand west into the planning area, they could move into further areas of development. Construction of oil pipelines to Prudhoe Bay could result in temporary disturbance of mixed-sex groups of muskoxen in the Colville River and Fish Creek areas. Repeated disturbance of the same group during the winter, by air traffic, for example could negatively affect the energy balance of individual animals and potentially contribute to winter mortality. Under Alternative A, lease stipulations are in place to minimize impacts to muskoxen—for example, by avoiding activities close to riparian habitat, prohibiting hunting by employees, limiting ground transportation, and controlling air traffic.

Grizzly Bears

Major sources of noise include construction of roads, installation of crude oil pipelines, pump stations, gravel mining, and drilling operations. These activities could disturb grizzly bears within a few miles of the noise sources and could keep bears from accessing their preferred denning sites. Industrial activities and human presence could also cause potentially serious disturbances to denning bears. In one study, seismic activities within 1.2 miles of a grizzly bear den caused changes in heart rate and movement of the female bear and cubs (Reynolds et al. 1986). The investigators suggest that seismic testing activities within about 600 feet of the den may cause abandonment of the den. A similar effect could occur from construction activities within 600 feet of dens. In a study of maternal denning of polar bears and their cubs (a comparable species), disturbances from capture, marking, and radio tracking did not affect litter sizes or the stature of cubs produced. This tolerance by bears, and the fact that maternal investment in the denning effort increases through the winter, indicate that spatial and temporal restrictions on development activities could prevent abandonment of the dens (Amstrup 1993).

Human scent and other noises could also disturb bears. When grizzly bears first encounter humans on foot, their initial response is to flee; responses to ground-based human activities are stronger than responses to aircraft, especially when encounters occur in open areas such as the North Slope (McLellan and Shackleton 1989). The increase in human presence and resulting encounters with grizzly bears associated with recreation and tourism are temporary in nature. The establishment of permanent settlements (oil fields, mines, etc.), however, usually leads to human-bear encounters on a regular basis and to conflict, particularly if bears learn to associate humans with food (Harding and Nagy 1980, Schallenberger 1980, Miller and Chihuly 1987, McLellan 1990). Grizzly bears initially avoid human settlements because of the noise and disturbance (Harding and Nagy 1980), but if the area includes an important food source, some bears are likely to habituate to the noise and human presence, leading to an increase in encounters. Individual bears, especially females with cubs, vary in the degree of habituation-tolerance to human presence, and some would continue to avoid areas when humans are present (Olson and Gilbert 1994). Although studies show cub survival is higher among bears using anthropogenic food sources in the oil field region (Prudhoe and Kuparuk), this effect is countered by the fact that these bears have a lower than normal survival rate after becoming sub-adults (Shideler and Hechtel 2000).

The attraction of grizzly bears to garbage or other food odors at oil and gas facilities has led to encounters in which the need to protect workers results in the loss of bears (Schallenberger 1980). Once bears become conditioned to the availability of human sources of food, measures to reduce this availability by improved garbage handling are not always effective (McCarthy and Seavoy 1994). The bears respond by making an extra effort to get to the food sources that they are conditioned to having.

Under Alternative A, oil exploration and development would likely attract some grizzly bears to oil production facilities, and could result in the loss of some bears due to interactions with humans, including mortality on roads. In addition, bears could be subjected to increased hunting pressure through improved access or increased human presence associated with oil development. The level of impacts to bears would be dependent upon the location of the oil fields. Bears are much less common in the ACP than in the foothills of the southern part of the planning area. Oil development in the area with the highest potential for oil reserves (the north) would initially have fewer impacts on bears than development in the middle to southern portion of the planning area. However, if bears were attracted to development, impacts could increase over time. Shideler and Hechtel (2000) estimated bear densities in the oil field region (Prudhoe Bay and Kuparuk river Unit) to be 1.5 bears per mi^2, more than twice the highest density estimate for the ACP. Because this higher density could not be attributed to anthropogenic food sources, the authors speculated that the oil field region was higher quality habitat than other parts of the ACP.

Gravel mining in riparian corridors along major rivers could result in the disturbance and loss of up to 550 acres of bear habitat. Shideler and Hechtel (2000) found that bears often used riparian habitats on the North Slope. On average, 51% of their observations of radio-collared bears were in riparian corridors along major rivers and streams.

Lease Stipulations 24, 29, 39, and 41 restrict industrial activities close to riparian habitat and bear dens, and should reduce impacts.

Wolves

Potential effects on wolves include short-term disturbances from air and surface traffic and human presence, and increased hunting and trapping pressure through improved access or

increased human presence associated with oil development. If caribou abundance were negatively affected by oil development, wolf abundance could in turn be affected. Wolves are generally not abundant in the planning area, and the highest populations are located in the southern portions of the area. Therefore, oil development in the high potential area would have an impact on a minimal number of wolves.

Wolverines

The potential effects of oil development on wolverines could include disturbance from air and surface vehicle traffic, increased human presence, and habitat alteration. Because wolverines are considered a shy and secretive species, they could be sensitive to oil exploration and development activities. Winter seismic activities in the Pik Dunes area south of Teshekpuk Lake caused the displacement of a wolverine from its den (Brower 1997 in USDOI BLM 1997). If caribou abundance were affected by oil development, wolverines could also be affected. Decline in the distribution and abundance of wolverines in Canada was attributed to increased harvest and decline in caribou populations (Van Zyll de Jong 1975). Alteration of riparian habitats through gravel excavation or pipeline construction could affect wolverines, especially during the winter, when these habitats provide cover and important hunting areas. Under Alternative A, some wolverines could be displaced near (within a few miles) oil field facilities. Lease stipulations that control or prohibit development activities near riparian areas in the vicinity of the Pik Dunes and in the Teshekpuk Lake Special Area would help mitigate impacts on wolverines.

Foxes

Oil development activities could affect Arctic and red fox populations by increasing the availability of food and shelter. Oil field facilities provide additional food sources for foxes at dumpster sites near the galley and dining halls and at dump sites (Eberhardt et al. 1982; Rodrigues et al. 1994). Crawl spaces under housing, culverts, and pipes provide foxes with shelter for resting and, in some cases, artificial dens (Eberhardt et al. 1982; Burgess and Banyas 1993). Localized oil development activities do not appear to have any dramatic, deleterious effect on Arctic fox populations (Eberhardt et al. 1982). A study of den sites and fox productivity near Prudhoe Bay indicates that adult fox densities and pup production are higher in the oil fields than in surrounding undeveloped areas (Burgess et al. 1993). An increase in the fox population associated with oil development could affect some prey species of foxes (such as ground-nesting birds and molting waterfowl) in the development area and over a region larger than the oil field itself. Standard waste management practices and employee training would reduce the likelihood that foxes would be attracted to oil field facilities.

Other Mammals

Small rodents and their predators would be affected locally (direct mortality and loss of habitat of individuals or small groups of lemmings and voles) along pipelines, gravel pads, and other facilities. Arctic ground squirrels sometimes den in gravel fill in the oil fields (Shideler and Hechtel 2000). The availability of suitable burrowing habitat could increase the local densities of ground squirrels.

Effects of Abandonment and Rehabilitation

Abandonment and rehabilitation activities would disturb and displace terrestrial mammals in a manner similar to that associated with construction. The intensity of the disturbance might be less than during construction, because it is possible that caribou, muskox, and other terrestrial mammals would have become habituated to road and air traffic over the course of construction and operation of the facilities. Some individuals could be killed by collisions with road traffic. If

roads were left in place and maintained in useable condition upon abandonment, they could continue to provide improved access to hunting areas, with consequent hunting pressure on caribou and other subsistence species. Revegetation of the roads, pads, and the airstrip left in place would facilitate restoration of habitat. Plant communities on these raised gravel structures would likely be different from those that prevail in adjacent areas. However, pads, roads, and airstrips, if left in place, could provide some insect-relief habitat for caribou. If gravel fill was removed and the pad revegetated with vegetation similar to the surrounding plant communities, caribou, and possibly other terrestrial mammals, would use the area. Foam insulating materials that could be used in pad construction could be broken up in the course of removal. If some of this foam escapes being cleaned up, it may be, used by fox as denning material. Depending on the material's toxicity and the amount ingested by fox, this could cause mortality, though the numbers of fox killed would likely be very small. Overall, the impacts of abandonment and rehabilitation activities would be measured as impacts to individuals; no adverse impacts to populations are expected.

Effects of Spills

Typical refined products that are spilled on the Alaska North Slope include aviation fuel, diesel fuel, engine oil, fuel oil, gasoline, grease, hydraulic oil, transformer oil, and transmission oil. The extent of environmental impacts would depend upon the type and amount of materials spilled, the location of the spill, and the effectiveness of the response. The majority of small spills would be contained on the gravel pad and would have no impact on terrestrial mammals or their habitat.

Caribou and other terrestrial mammals could be coated with oil or ingest contaminated vegetation. Adult caribou, moose, and muskox that were to become oiled would not likely suffer from a loss of thermal insulation during the summer, although toxic hydrocarbons could be absorbed through the skin or inhaled. However, the oiling of young calves could reduce thermal insulation, leading to their death (USDOI BLM and MMS 1998). Oiled caribou, moose, and muskox hair would be shed during the summer before the winter fur was grown. If animals were oiled in the winter after shedding their summer coats, oiling may affect thermal insulation and result in winter mortality. No documented caribou deaths have been attributed to spills associated with TAPS. Toxicity studies of crude-oil ingestion in cattle indicate that anorexia (substantial weight loss) and aspiration pneumonia leading to death are possible effects (Rowe et al. 1973). Exposure of livestock (horses and cattle) utilizing grazing lands with oil development has resulted in mortality and morbidity (Edwards 1985). Exposure could involve heavy metals, salt water, caustic chemicals, crude oil, and condensates. In cattle, this exposure has been shown to result in a wide variety of symptoms including effects on the central nervous system, cardio-pulmonary abnormalities, gastrointestinal disorders, inhalation pneumonia, and sudden death. Caribou, moose, and muskox that become oiled by contact with a spill in contaminated lakes, ponds, rivers, or coastal waters could die from toxic hydrocarbon inhalation and absorption through the skin. In addition to acute toxicity, mortality from chronic effects could occur well after a spill.

Spill response would disturb terrestrial mammals; some oiled animals could be captured for treatment, while non-oiled animals could potentially be hazed from the area under agency guidance. The extent of the disturbance would depend upon a variety of factors, including spill size and location, response actions, and season. Aircraft or overland vehicles would temporarily disturb terrestrial mammals present in the vicinity of the spill. Response to disturbance could last from a few minutes to a few hours. Larger and more mobile terrestrial mammals would be temporarily displaced by human activity around the clean-up site; displacement could last for a

few days to a few weeks. Small mammals, such as lemmings and voles, could be killed during clean-up activities. It is not expected that these disturbance impacts would have population level effects on any terrestrial mammals.

If an oil release from a pipeline, or a spill large enough to escape from a gravel facility pad were to occur, some tundra vegetation would become contaminated. Caribou, moose, and muskox probably would not ingest oiled vegetation, because they tend to be selective grazers and are particular about the plants they consume (Kuropat and Bryant 1980). For most spills, control and clean-up operations (ground traffic, air traffic, and personnel) at the spill site would frighten caribou, moose, and muskox away from the spill and limit the likelihood that these animals would graze on the oiled vegetation. In most cases, onshore oil spills would not be expected to affect caribou, moose, and muskox through ingestion of oiled vegetation. For large spills that are not immediately or successfully cleaned up, the potential for contamination would persist for a longer time and there would be a greater likelihood of animals being exposed to the oil. Cleanup success would likely vary depending upon the environment. Over time, any remaining oil would gradually degrade. Although oiling of animals would be unlikely to remain a threat after clean-up efforts, some toxic products could remain for some time. Depending upon the spill environment, a portion of the oil could persist for five years (USDOI BLM and MMS 1998).

Oil spills on wet tundra would kill the moss layers and aboveground parts of vascular plants and could potentially kill all of the macroflora at the site (McKendrick and Mitchell 1978). Damage to oil-sensitive mosses could persist for several years if the site were not rehabilitated. The length of time that a spill would persist would be dependent upon soil moisture and concentration of the product spilled. McKendrick (2000) reported that complete vegetation recovery occurred within 20 years on a wet sedge meadow without any cleanup. At a dry habitat exposed to the same application, vegetation cover was less than 5% after 24 years. For the most part, onshore oil spills would be very localized (less than one acre) in their effects and would not be expected to substantially contaminate or alter caribou, moose, and muskox habitat. However, some local contamination of tundra vegetation would likely occur near production wells and processing facilities. Spills occurring within or near streams and lakes could affect foraging habitat along these waterbodies.

Grizzly bears depend on coastal streams, beaches, mudflats, and river mouths during the summer and fall for catching fish and finding carrion. If an oil spill were to contaminate beaches and tidal flats along the Beaufort Sea coast (an extremely unlikely situation under the Alternative A), some grizzly bears would be likely to ingest contaminated food, such as oiled birds, seals, or other carrion (USDOI BLM and MMS 1998). Such ingestion could result in the loss of some bears through acute toxicity. An oiling experiment on captive polar bears indicated that if a bear's fur becomes oiled and the bear ingests a considerable amount of oil while grooming, kidney failure and other complications could lead to the bear's death (Oritsland et al. 1981). Brown bears on the Shelikof Strait Coast of Katmai National Park (an area contacted by the Exxon Valdez oil spill) were observed with oil on their fur and were consuming oiled carcasses; one young bear that died had high concentrations of aromatic hydrocarbons in its bile and might have died from oil ingestion (Lewis and Sellers 1991). Anecdotal accounts of polar bears deliberately ingesting hydraulic and motor oil, and foreign objects from human garbage sites suggest that both bear species are vulnerable to ingesting oil directly, especially from oiled carrion and other contaminated food sources (Derocher and Stirling 1991). Skin damage and temporary loss of hair can result from oiling of bears, with effects on thermal insulation. Alternative A could result in the loss of a very small number of grizzly bears through ingestion of contaminated prey or carrion.

Small mammals and furbearers could be affected by spills due to oiling or ingestion of contaminated forage or prey items. These impacts would be localized around the spill area and would not have population level impacts.

If seawater were used for enhancement of oil production, a saltwater spill could occur within the planning area. According to McKendrick (2000), brine spills kill plants on contact and increase soil salinity to the point that many species cannot survive. Unlike oil, salts are not biodegradable, and natural recovery occurs only after salts have leached from the soil. A spill would have effects on salt-intolerant vegetation near the seawater pipeline, but the amount of tundra habitat affected would be no more than a few acres. Thus, saltwater spills would probably not affect forage availability for caribou, muskox, moose, or other terrestrial mammals in the planning area. In cattle, ingestion of saltwater at greater than 10,000 ppm salt can cause sodium-ion toxicity and at lower levels may affect rumen activity (Edwards 1985). In the case of a saltwater spill on tundra habitat, the water would likely be adsorbed into the vegetative mat or in wet habitats, diluted with fresh water. Cleanup and rehabilitation activities would likely keep terrestrial wildlife out of the spill area for the short term. Over the long term, mortality of vegetation in the area affected by the spill would make the area undesirable for grazing by terrestrial mammals until the vegetation recovered.

In the event of a natural gas-well blowout or pipeline rupture, there would be a short-term release of gas (less than one day) which could extend downwind for about ½ mile and would quickly dissipate once the blowout or leak was stopped. Terrestrial mammals in the immediate vicinity of the blowout could be killed. Natural gas and condensates that did not burn in the blowout would be hazardous to any terrestrial mammal exposed to high concentrations. Given the small area that would be exposed to the plume and the rapid dissipation of the gas, it is not likely that any animals other than individuals present in the immediate vicinity at the time of the blowout would be affected. The likelihood of caribou, moose, muskox, wolves, or grizzly bears being exposed to toxic amounts of gas and condensates would be very minor and would probably only affect a few individuals. Smaller, less mobile species with small home ranges, such as squirrels, voles, and lemmings could be affected in larger numbers. However, there would be no population level impacts on these species.

Commercial Gas Development

If gas pipelines leading from CPFs to gas pipelines east of the planning are buried, they would have no impact on caribou movement except during the winters in which the pipeline was constructed and whatever impacts may be associated with a 10- to 20-acre compressor station whose noise may cause avoidance, but whose raised surface may attract caribou seeking insect relief. The construction disturbance would be similar to that associated with building aboveground oil pipelines. In addition, up to about 290 acres of caribou habitat would be altered by change in vegetation along the buried pipeline route.

If a gas pipeline was elevated on a set of VSMs separate from oil-pipeline bearing VSMs, there could be additional impacts to caribou movement. As described above in **section 4.3.9.1**, under certain circumstances caribou may alter their movements or delay for a short period of time passing under an elevated pipeline. Passing through parallel sets of pipelines can further delay transit, though the impact of multiple pipelines (or roads) can be reduced if the structures are separated by 500 feet.

Construction and operation of gas facilities would likely impact other terrestrial mammals in a manner similar to and in like proportion to the impacts associated with oil development. Elevated pipelines generally do not impact most species, though moose prefer movement through pipeline elevated higher than the 5-foot height required in Alternative A (Sopuck and Vernam 1984). Winter construction may disturb denning brown bears, resulting in bears expending increased energy and potentially leaving the den. Any cubs in the den would most likely die if the den were abandoned.

In the event of a natural gas well blowout or pipeline rupture, there would be a short-term release of gas (one day) that could extend downwind for about 1 km and would quickly dissipate once the blowout or leak was stopped. Terrestrial mammals in the immediate vicinity of the blowout could be killed. Natural gas and condensates that did not burn in the blowout would be hazardous to any terrestrial mammal exposed to high concentrations. Given the small area that would be exposed to the plume and the rapid dissipation of the gas, it is not likely that any animals other than individuals present in the immediate vicinity at the time of the blowout would be affected. The likelihood of caribou, moose, muskoxen, wolves, or grizzly bears being exposed to toxic amounts of gas and condensates is very low and (should it occur) would probably only affect a few individuals. Smaller, less mobile species with small home ranges, such as squirrels, voles, and lemmings may be affected in larger numbers. However, there would be no population level impacts on any species.

4.3.9-a.3 Effectiveness of Stipulations

Lease stipulations described in the 1998 Northeast IAP/EIS ROD (USDOI BLM and MMS 1998) would reduce the impacts of development under Alternative A.

Several Lease Stipulations (1 through 17) that specifically address solid and liquid-waste disposal, fuel handling, and spill cleanup should reduce the potential effects of oils and other waste on terrestrial mammals. Lease Stipulation 24(a-n) addresses overland moves and seismic work and would minimize alteration of terrestrial mammal habitats, while Lease Stipulation 55 requiring that aircraft maintain an altitude of 1,000 feet AGL (except for takeoffs and landings) over caribou winter ranges from October through May 15, and an altitude of 2,000 feet AGL over the Teshekpuk Lake Caribou Habitat LUEA from May 16 through July 31, along with Lease Stipulations 52-54 and 57 (limiting flights) should minimize aircraft disturbance of caribou.

Lease stipulations (29, 31-37, 40, 43, 45, 46 and 48) addressing oil and gas development, including facility design and construction of pipelines, roads, drill pads, airstrips, and other facilities, as well as ground transportation, should minimize interference with caribou movements and the amount of terrestrial mammal habitat altered by gravel pads and other surface disturbances. The setbacks outlined in lease stipulations associated with development near rivers and lakes (39a-I and 41) would be particularly effective at minimizing impacts to terrestrial mammals such as caribou, moose, and muskox.

4.3.9-a.4 Conclusion

Terrestrial mammal populations that could be affected by management actions under Alternative A include the TLH, WAH, and CAH caribou. However, impacts to caribou would be greatly limited, since permanent oil and gas surface occupancy would not be permitted in the Teshekpuk Lake Surface Protection Area, which is a subset of the Teshekpuk Lake Special Area. Caribou could be temporarily exposed to helicopter traffic and other human activities

associated with resource inventories, seismic operations, exploratory drilling, and pipeline construction, but such exposure would not be expected to have any effects at the population level. The TLH caribou movements within insect-relief areas could be disrupted by oil development activities, which could impact herd productivity. However, most insect-relief habitat in the planning area used by the TLH would be protected by lease stipulations under Alternative A; therefore any impacts to herd productivity would likely be minor. The WAH caribou could also be exposed to oil development facilities in localized areas. Moose, muskoxen, grizzly bears, wolves, wolverines, foxes, and small mammals could be locally affected by activities associated with oil and gas exploration and development. In general, management actions would not affect terrestrial mammal populations in the planning area. There would be some permanent loss of habitat associated with gravel placement, as well as potential avoidance of areas where development occurs. Noise associated with development would cause a temporary disruption of normal behavior patterns, but would be unlikely to cause any long-term impacts to the animals. Bears and foxes could be attracted to developments, although the attractiveness of developments could be limited by proper waste handling.

In general, impacts to mammals from non-oil and gas activities, and from oil and gas activities, would likely be additive, except in those areas where both types of activities occurred. Impacts to mammals from exploration and development activities would also be additive, except where development occurred in areas previously disturbed during exploration. In areas where two or more activities occurred, overall impacts would reflect those impacts associated with the first activity and any new impacts associated with later activities. Based on the amount of habitat with a potential to be affected, the potential for impacts to mammals under this alternative would be about 87% (Alternative B), 83% (Alternative C) or 92% (Alternative D) as much for oil exploration and development activities, as compared to the action alternatives. If oil and gas activities occurred in areas with an abundance of caribou or other mammals, or in areas with high quality habitat, impacts could be greater than those based strictly on number of acres of habitat impacted.

4.3.9-b Marine Mammals

4.3.9-b.1 Activities Not Associated With Oil and Gas Exploration and Development

The principle non-oil and gas activities occurring in the planning area would be aircraft traffic (both rotary- and fixed-wing) associated with surveys and wildlife studies; ground activities such as resource inventories, paleontological excavations and research, and recreational camps; overland traffic; and human foot traffic. Overland moves would occur during the winter on stable sea ice or frozen tundra, and could impact small numbers of seals. Most of the other non-oil and gas activities would take place in summer and early fall (June-September) and could only impact marine mammals if they occurred along the coast of the planning area. These types of activities would be either highly localized (worksite/camp) or transient (surveys and inventories) could cause short-term (hours for a single event, or several days to 2-3 weeks if a camp or worksite is located immediately next to the coast in areas used by marine mammals) displacement or limited harassment of hauled-out seals.

Overland moves would take place during the winter, and follow routes from Prudhoe Bay or Oliktok Point to Barrow or Nuiqsut. Overland routes would occur over stable sea-ice and over frozen tundra. Vehicle and sled trains could disturb denning ringed seals if the routes occurred over denning habitat in floating fast-ice, and could temporarily displace basking seals near the traffic route. Most over-ice routes are expected to be over land-fast ice and across shallow

water (<10 feet). Ringed seals occur in very low densities in these shallower areas (~0.03 seals/mi^2) and do not appear to be significantly affected by construction and operation on sea ice roads (Moulton et al. 2005).

Small fuel spills would likely occur in association with resource inventories and surveys, recreational activities, and overland moves. These spills would most likely involve aviation fuel and other light-fraction hydrocarbons fuels that would evaporate and disperse rapidly, and would be cleaned up immediately whenever possible. These small spills would not be expected to impact marine mammals in or near the planning area.

The effects of non-oil and gas activities on marine mammals in the planning area should be localized and short term.

4.3.9-b.2 Oil and Gas Exploration and Development Activities

The development scenarios do not include off-shore structures or other permanent facilities. None of the marine mammals that occur regularly near or within the planning area regularly use terrestrial environments, with the exception of polar bears (addressed in **section 4.3.10**). Those seals that do haul out onshore during summer months are limited to the immediate coastal area. Therefore the primary potential impacts to marine mammals are from disturbance (noise and visual), contaminant spills, and collisions with ships. Each alternative has the potential for these impacts, however, the frequency, spatial extent, and magnitude (intensity and duration) likely will vary between alternatives. Some species (e.g. belugas) may enter river systems and may be impacted by changes in in-water conditions or geomorphology from development, particularly changes that could increase stranding, or reduce access to food resources.

Disturbance activities may over-ice seismic surveys occurring in lagoons and bays within the planning area; shipping, to bring exploration, drilling, and construction equipment and supplies, large modules, and annual re-supply and maintenance materials once development commenced. Air traffic may also have auditory and visual disturbance effects.

Contaminant may enter the water system from on-shore spills that reached rivers or the marine systems directly or they may occur as a result of shipping. Petroleum based material spills are the most likely to enter the marine system and impact marine mammals.

Ships strikes of marine mammals are generally expected to impact the whale species more than seals. Strikes may include direct collisions or contact with propellers.

Effects of Disturbances

Seismic

Onshore seismic surveys would not be expected to have any impacts on marine mammal species since none of the marine mammals addressed here occur onshore during the winter when seismic would occur.

Small areas off-shore in the Atigaru Point area inside the barrier islands (Map 2-1) would be open and seismic activity may occur. It is expected that any seismic activity would be done over ice, therefore only ice seals would have the potential to be affected. These areas are shallow (<10 feet). Ringed seals are less common in these shallow areas than in deeper water (Moulton

et al. 2005). Disturbance distances for on-ice activity have not been determined for ice seals, but seal density near Northstar was not affected by construction drilling, or, operation. Some reduced density following over-ice vibroseis was noted but the effect was minor compared to natural factors (Moulton et al. 2005). Any seismic that did occur in this area would be limited to one season and would occur in winter. Seals are expected to occur at very low density if at all in this area; however, some avoidance of the area may occur. Seals that did not abandon the area may be subject to more 'startle" events resulting in increased diving activity.

Visual and Noise Disturbance

Aircraft

Potential noise disturbance to marine mammals could result from support aircraft for exploration and development. Most aircraft flights would originate from Prudhoe Bay/Deadhorse or the Alpine air field. Some may originate from the Barrow Airport. Most flights to support exploration occur during winter months; summer flights to support exploration typically are conducted in mid-July and are related to equipment maintenance over a period of 10-14 days (BLM 2004). Limited information on the effects of aircraft on marine mammals in the arctic exists. Information that is available suggests alert behavior is the most common reaction for ringed seals (Richardson and Williams 2004, Moulton et al. 2005) and short-term avoidance responses (diving/direction change) (Born et al. 1999, Patenaude et al. 2002, Richardson and Williams 2004) that do not persist after the aircraft has left the area.

Flights in support of construction and development would include both rotary- and fixed-wing aircraft, also likely originating from Deadhorse/Prudhoe, Alpine, or Barrow. These flights are expected to be more numerous, particularly during prior to and during construction. Helicopter flights can be numerous immediately prior to and during construction, however, the majority of these are in support of field studies and are relatively short flights in the immediate vicinity of the development (e.g. Johnson et al. 2006). Although there likely will be many flights, it is expected that primarily fixed-wing aircraft would be over the Beaufort. The number of flights and duration over water would be dependent on which airport the aircraft originated from and where the airstrip they were landing at was. Because the area surrounding Teshekpuk Lake would not be leased or would have no surface activity restrictions and because of the relative location of airports, it is expected that the number and length of flights over the Beaufort would be limited compared to other alternatives.

Effects on seals should be localized (within approximate ¼ mile flight path) and short-term (lasting only for the duration the flights are overhead and within ~1 mile lateral distances) (Born, 1999), but could cause displacement from preferred resting and feeding locations. Available information suggests minor responses to fixed wings at altitudes ≤ 300 feet and don't suggest area abandonment (Born et al. 1999; Moulton et al. 2005; Richardson and Williams 2004). Overflights by fixed-wing aircraft or helicopters could cause the temporary displacement of seals from their haul outs. Aircraft would be required to be above 300 feet in altitude, except on takeoff and landing, which would reduce the potential for aircraft disturbance. The number of seals affected would depend on the number of disturbance incidents and the number of seals hauled out on the ice. Moulton et al. (2003) reported minor responses by seals to fixed-wing surveys flown at 300 feet; only 1.5% of the observed seals were reported to dive into their holes in response to the aircraft. Aircraft routes would not likely occur over ringed seal pupping habitat, so no impacts to ringed seal pups are expected.

Grey whales, killer whales, and harbour porpoise may be in near shore waters and may be exposed to some aircraft. Given the apparent rarity of these species in the area offshore of the planning area (Suydam and George 1992, George and Suydam 1998, Moore et al. 2006) and the relatively low number of expected flights that would occur over marine waters under this alternative, disturbance effects are expected to be minimal. If flights regularly originate/return to the Barrow airport there is a greater chance that aircraft could encounter these animals.

During the summer, some of the air traffic to and from exploration and production facilities could disturb ringed, bearded, and spotted seals hauled out on nearshore ice or on beaches. Such disturbance could result in the displacement of seals into the water. Aircraft disturbance to seals hauled out along the coast or on nearshore ice would not be expected to result in the death of any seals, although increases in physiological stress resulting from frequent disturbance could reduce the fitness of individual seals.

Under Alternative A, seals could be affected by possible offshore oil exploration and subsequent development on the coast of the planning area in a small area south of Atigaru Point (Map 2-1). The effects of these activities would be localized and would not be likely to affect marine mammal populations. Most exploration and development activities would occur onshore, where they would be unlikely to affect individual marine mammals or populations. Development and operation of Northstar did not result in any changes in density of ringed seals even though ringed seal density is much higher around Northstar (Moulton et al. 2005) than would be expected in the shallow waters off Atigaru Point.

Shipping

Most boat traffic associated with exploration and development within the planning area is expected to be either multi-vessel sealifts to support construction, or single transport vessel for annual re-supply/new/equipment. Some small vessel traffic may also occur for oil spill response practice.

The reasonably foreseeable development scenario for Alternative A assumes that each of the five potential CPFs would require 1-2 sealifts over 1-2 years (one per year) with each sealift consisting of up to 30 barges. This would total 5-10 sealifts and as many 150-300 total barges. The development scenario assumes that development of CPFs would not occur concurrently but sequentially with approximate 10 years between starts with the same gap between these major sealifts. Sea-lifts and regular support shipping typically take place in late July through September to take advantage of the reduced ice and to avoid conflict with subsistence whaling.

Sea lifts to support construction would likely come ashore along the northern coast of the planning area and material would be stored at a staging area until ice roads could be constructed and the material then would be moved overland to the construction site.

Because barge loads are frequently consolidated, and different leasees may chose alternate transport (truck and aircraft), no estimate of re-supply vessel trips is made. There would be some amount of increase in average annual traffic associated with exploration and operation on the North Slope, but it is expected that the number of trips associated with the planning area would be substantially less than required for construction. Much of that material may come ashore at the Prudhoe area where facilities for storage exist and be transported overland or by air, with only heavier equipment landed in the planning area.

Marine mammals that occur in or adjacent to the planning area react to and maneuver to avoid boats. However, the distance at which they react is dependent on the species, individual, activity/season, type size and behavior of boat, and physical conditions (review in (Richardson et al. 1995). The duration and severity of the avoidance behavior also seems to vary, with some evidence that whales actively avoid shipping lanes, and other reports of possible habituation (Moore and Clarke 2002).

Vessel traffic associated with exploration and development may encounter multiple individuals of several species of marine mammals. Encounter times would be relatively short and individuals would likely encounter the vessel once in any period, possibly twice as vessels would be traveling point to point, unlike survey ships or seismic vessels. Shipping activity would take place after calving/birthing periods and when animals are typically well distributed foraging, or possibly during the beginning of early fall migration. Beluga, which tend to react at long distances and avoid areas of vessel activity for days during spring migration while moving leads (Richardson et al 1995) are usually far off-shore (Moore et al. 2000, Suydam et al. 2005) and less sensitive to ships during this period. Other whales and seals are expected to have short-term, short distance avoidance behaviors, which may reduce feeding opportunities, but are not expected to result in abandonment of foraging areas, or measurable declines in body condition as a result (Richardson et al. 1995).

If shipping occurred during early migration and it caused migrating whales to deflect oceanward and bypass high density foraging areas some effects to whale fitness may occur, but given the short duration and limited number of disturbance events resulting from development in the planning area, the effects are not expected to result in reduced reproductive rates or direct mortality.

Contaminant Spills

Effects from a Large Spill. Two to three large pipeline spills (4,800 bbls) are considered likely to occur in the planning area under this Alternative (**Section 4.2.2.2**). However, no offshore development is anticipated and the conditions necessary for a terrestrial spill to reach areas used by marine mammals are unlikely to occur. For a spill to affect marine mammals it would have to be of sufficient size to reach areas used by marine mammals either through overland flow or by river transport and it would have to reach areas used by marine mammals in sufficient concentration to impact marine mammals. Several factors combine to make these circumstances unlikely. The majority of the planning area coastline is unavailable for development, and the relative length of coastline that is available is short. Stipulation 39 requires a minimum of ½ mile setbacks from major rivers including pipelines but not excluding crossings. Tundra is capable of "storing" 300 -1,500 bbls of oil (**section 4.2.2.3**); therefore, any spill occurring greater than approximately 0.2 miles from a river would not be expected to enter the river (Spill Volume/Midpoint of storage capacity [900 bbls] x side length of an acre). Finally all leasees must have a spill response plan to include containment and cleanup which would be expected to substantially lessen oil spread in all events except in the unlikely event of a large spill occurring directly into a river channel during the broken ice period. Although a large spill may occur under this alternative and it is possible it could reach areas used by marine mammals, it is improbable that series of events and chance necessary would occur.

If a large spill occurred near the Colville River Delta, some oil could reach the marine environment. Some spotted seals and beluga whales within the Colville River Delta could be exposed to oil if the spill occurred during the open-water season. A spill could affect ringed seals if it occurred during spring break-up. Assuming that the spill occurred during the open-water

season, the coastline of many small islands in the Colville River Delta could be oiled. A small number of spotted seals regularly use the Colville River main channel and Nigliq Channel in summer. Johnson et al. (1998, 1999) reported spotted seals in the East Channel of the Colville River, at the mouth of the Kachemach River, and on the southwest end of Anachlik Island. Local residents of Nuiqsut reported that spotted seals regularly use Nigliq Channel, and the Fish Creek and Judy Creek deltas. Spotted seals have been observed as far upstream as Ocean Point, and occur regularly as far as the mouth of the Itkilik River (Reed 1956; Seaman et al. 1981). There are limited records of coastal sightings of beluga whales near the Colville River Delta. Beluga whales are common near shorefast ice in the Colville River Delta region until ice moves offshore in July. Seaman et al. (1981) reported sightings of a few groups, ranging up to 100 beluga whales, near Jones, Pingok, and Thetis islands, north and east of the Colville River Delta, during fall migration. Recently, Nuiqsut hunters reported that beluga whales have been seen in Niglik Channel in the Colville River, and were seen stranded in shallow water in the Fish Creek Delta (Lampe 2003).

Effects from Small Onshore Spills. Small onshore spills would generally not have any effects on marine mammals unless the spills entered and contaminated streams that run into the Colville River Delta, Fish Creek or Judy Creek, or the Kogru River. Although small spills are expected to happen under this alternative, because of the much lower expected spill volume (<500 bbls) it is even more unlikely that oil would reach areas used by marine mammals.

If small spill should enter a river system directly, no containment or cleanup impacts are possible, although as noted this is highly unlikely. Spotted seals and belugas do occur in the lower portions of the Colville system and its tributaries. The number that could be affected would be dependent on when the spill occurred and the density and location of the seals/whales relative to the spill. In this scenario, a small number of spotted seals or beluga whales might be exposed to oil in nearshore habitats and suffer lethal or sublethal effects. A small number of ringed seals and their pups could be contaminated if a spill were to reach the marine environment during early winter. Such contamination could result in the death of a small number of pups. If the spill occurred during the open-water season, a small number of spotted seals could be exposed to oil. A few spotted seals could suffer sublethal or lethal effects. A small number of beluga whales could be exposed to oil in the Colville River Delta and in Fish or Judy creeks. The small number of deaths that could occur from small onshore spills is not expected to affect seal, or beluga, populations in the Beaufort and Chukchi seas. Small onshore spills would be unlikely to affect bearded seals, walruses or gray whales that occur offshore of the planning area.

Vessel Strikes

Vessels may strike and injure or kill marine mammals (Laist et al. 2001), and are the main source of anthropogenic mortality preventing the North Atlantic right whale from recovering (Kraus, 1990). Direct collisions have resulted in mortality and injury to whale species. Contact with the propeller(s) and direct collisions are known to injure bowhead whales and other large marine mammals (George et al. 1994; review in Laist et al. 2001).

Based on behavior and habitat use, it is more likely that whale species would be struck than seal species, and that larger, slower, or less reactive species would have greater potential to be struck. While all sizes of vessels have been involved in collisions with whales, vessel size and speed are factors in determining whether a collision results in severe injury or death. Ships over 260 feet long are more likely to cause sever injury or death as are vessels traveling 14 knots (16 mph) (Laist et al. 2001). Barges transiting the Beaufort Sea usually travel at 6-7

knots (7-8 mph) or half the speed associated with most severe injury or mortality. Total length of barge – tow vessel may be greater than 260 feet but it is not known if they are equally likely as a self contained vessel to cause severe injury in a collision.

George et al (1994) found that approximately 1% of bowheads taken by subsistence whaling had been struck by propellers. No information regarding mortality rates from strikes in the Beaufort of Chukchi Sea were found; however, compared to other areas where shipping occurs at greater rates, greater speeds and year around (review in Laist et al. 2001) mortality and injury rates are expected to continue to be low and the increase in vessel traffic due to development in the planning area would only minimally increase the potential for strikes and is not expected to have a population level effect.

Effects of Abandonment and Rehabilitation

Impacts of abandonment and rehabilitation activities are expected to be similar to those for construction. Given the expense of transport vessel traffic is expected to be somewhat lower than occurred during construction as large modules or other equipment may be moved to other development or stored at regional staging areas rather than moving it off the North Slope.

4.3.9-b.3 Effectiveness of Stipulations

Lease Stipulations 1 through 17 concern waste prevention, handling, and disposal, and spills. These lease stipulations should be effective in reducing potential marine pollution and its effects on marine mammals in the Colville River Delta where oil exploration and development could occur under Alternative A. Lease stipulations addressing waste prevention, and handling and disposal of food and garbage should also be effective in preventing or minimizing attraction of polar bears to oil field camps by minimizing food odors, although curious bears might still approach camps. Minimizing or preventing polar bear attraction should reduce the potential for negative bear-human interactions and reduce the likelihood of bears being killed in defense of human life and property.

Lease Stipulation 24(a) would require consultation with the USFWS before overland moves or seismic surveys could be conducted within 25 miles of the coast. Lease Stipulation 39 would require setbacks 1/2 mile or greater for Fish Creek, Judy Creek, and the Colville River. These lease stipulations should be effective in preventing disturbance to spotted seals, and perhaps beluga whales, that inhabit the waters of the Colville River Delta, Fish Creek, and Judy Creek during the open-water season.

Lease Stipulation 63 would require lessees to implement a program to inform personnel about the importance of not disturbing biological resources, including marine mammals. This lease stipulation should be effective in minimizing direct disturbance to marine mammals from human activities. Lease Stipulation 77 would encourage operators to apply for a letter of authorization from the USFWS to conduct activities in polar bear denning areas. This lease stipulation would be effective in minimizing disturbance to denning polar bears.

Permanent oil and gas surface occupancy and seasonal exploratory or delineation wells would not be permitted in the Teshekpuk Lake Surface Protection Area. This measure would preclude disturbance to marine mammals from onshore oil and gas activities along the coast of the planning area from north of the Kogru River to the east side of Smith Bay. Ice roads, seismic activities and winter overland moves could be authorized in the planning area, but the lease stipulations described above should prevent these activities from disturbing marine mammals.

4.3.9-b.4 Conclusion

Under Alternative A, the effects of non-oil and gas activities on marine mammals, particularly ringed seals along the coast of the planning area, would likely be short term and localized and occur within 1 mile of aircraft corridors, survey sites, recreational camps, and overland moves The effects of oil and gas leasing and development activities would likely cause increases in noise and disturbance, primarily near the Colville River Delta and Inner Harrison Bay areas and along shipping paths. Effects would be localized (within 1 mile of aircraft corridors and activities) and short term (generally <1 shipping event/year) and should have minor effects on marine mammals.

A small number of ringed seals, spotted seals, and beluga whales could be affected by oil spills reaching Fish Creek, Judy Creek, the Kogru River, the Colville River, or drainages that empty into the Colville River. Such an event is highly unlikely but if it did occur it is expected that the mortality would be minor, and would not substantially impact marine mammal populations.

The effects of development under Alternative A on marine mammals would likely be short term. Overall, it is not expected that oil exploration and development activities under Alternative A would have a measurable effect on marine mammal populations in or adjacent to the planning area. Since nearly all exploration and development activity would occur onshore, impacts to marine mammal resources under Alternative A would be similar to, or slightly less than, those that would occur under the Alternative D and alternatives B and C.

4.3.10 Threatened and Endangered Species

Management actions in the planning area could affect the endangered bowhead whale, which would be present in the Beaufort Sea offshore of the planning area, primarily from August through October. In addition, two threatened bird species, spectacled and Steller's eiders, could potentially be affected by management actions in the planning area under Alternative A. Polar bears were proposed for listing as threatened throughout their range January 9, 2007 (USFWS, 2007) and are also included in this section. Activities that could affect listed and proposed species include oil and gas exploration and development, subsistence hunting, recreational use, and activities associated with scientific survey and research camps. Spectacled and Steller's eiders are most likely to be affected. Spectacled eiders are distributed in low densities throughout much of the planning area, with the highest concentrations occurring in wetland habitats north of Teshekpuk Lake (Larned, 2006; Map 3-32). Steller's eiders occur in much lower densities (average density over 15 years = $0.01/mi^2$; Larned et al 2006), with no known areas of concentration within the planning area. Polar bears largely occur offshore in association with ice but have been recorded denning along the northern coast of the planning area (Map 3-29) and may be occasional visitors elsewhere.

4.3.10-a Bowhead Whale

4.3.10-a.1 Activities Not Associated With Oil and Gas Exploration and Development

Under Alternative A, bowhead whales would be disturbed by non-oil and gas activities only under exceptional circumstances. Such circumstances could occur when whales migrate near the coast when barge traffic was present, or possibly from air traffic, supply camps, or aerial surveys located along barrier islands or offshore areas. Effects would likely be localized and short term, and would be unlikely to have a high impact on individuals or the population (Richardson and Malme 1993, Richardson and Williams 2002, USDOI BLM and MMS 2003).

4.3.10.2 Oil and Gas Exploration and Development Activities

Effects of Disturbances

Under Alternative A, the coastline north of the Kogru River would be unavailable for oil and gas leasing. Only a small portion of the coast, and a small area in Harrison Bay, south of Atigaru Point, would be available for development. Bowhead whales generally do not enter Harrison Bay during the fall westward migration (Treacy 1988-1997, 2000-2002). No drilling activities would occur in OCS waters under this alternative. Types of potential impacts on bowheads are the same as discussed for marine mammals in **section 4.3.9-b.2**. Noise-producing activities, including most seismic surveys and all drilling activities, would take place in winter (early December to mid-April), and onshore. It is possible that some seismic data collection could occur landward of the barrier islands at Atigaru Point and the Koguru River but in these areas seismic is expected to be conducted in the winter over ice, not in open water. Therefore, it is unlikely that any impacts to bowhead whales would occur from exploration activities under Alternative A.

Visual and Noise Disturbance

Aircraft

Aircraft flying at altitudes greater than 1,000 feet AGL generally do not affect bowhead whales (Patenaude et al., 2002). It is unlikely that flights supporting oil and gas operations in the planning area would occur over marine waters beyond the nearshore zone, and these activities should therefore be well outside the bowhead whale migration corridor. The effect of aircraft traffic on bowhead whale behavior would likely be localized and short term.

Under Alternative A, aircraft associated with development are unlikely to occur over waters occupied by bowhead whales given the location of the two major airports of origin and the fact that no leasing would occur in the Teshekpuk Lake area. Fixed-wing aircraft may occur, particularly over Harrison Bay, if weather or other flight restrictions cause pilots to turn over the area to approach or leave an airstrip in Northeast NPR-A, but helicopter traffic is unlikely.

Fixed-wing aircraft flying at ≥500 feet altitude frequently resulted in rapid diving of overflown bowheads. Repeated low-altitude overflights at 500 feet during aerial photogrammetry studies of feeding bowheads sometimes caused abrupt turns and quick dives (Richardson and Malme, 1993). A study of bowhead reactions to experimental twin otter aircraft overflights during spring migration through the lead system found that aircraft elevation and altitude influence reaction rates. Very few whales reacted to any overflights, but of those that did most reacted to

aircraft less than 600 feet in elevation and 820 feet lateral distance from the whales (Patenaude et al. 2002).

The lack of an overt response from aircraft should not be interpreted as the lack of an effect. Undetectable changes in behavior such as succession of feeding, or other behaviors may have occurred. However, it is unlikely that the relative effect rose to a level that would affect the fitness of the animal. Repeated low-level overflights may cause sufficient disturbance to produce an impact. The expected low number of flights that would occur over areas used by bowhead, the low number of bowhead likely to occur in areas potentially overflown, and the fact that normal operating elevations are great enough that no effect would be predicted by available information suggest that aircraft activity under Alternative A is unlikely to impact bowhead whale.

Shipping

Bowheads exhibit strong and consistent avoidance behavior if approached directly by vessels; reacting to ships at 2.5 miles or greater (Richardson 1995). Avoidance behavior appears to be generally temporary but may displace whales several miles. Research to determine if individual short term displacement from ship traffic has a significant effect on individuals is lacking.

Noise-producing marine vessel and aircraft traffic would be the most probable source of disturbance to bowhead whales under this alternative. Although bowhead whales could encounter a few vessels associated with oil and gas activities in the planning area during their fall migration through the Beaufort Sea, most of the vessel activity would be in shallow, nearshore waters in Harrison Bay, which is rarely traversed by migrating bowhead whales (Treacy 1988-1997, 2000-2002). The effects of vessel traffic on bowhead whales would likely be localized and short term, although it is unknown if disturbance from shipping traffic leads to significant impacts to whales. Whalers in Barrow perceived that bowhead whales migrated farther from shore in 2003 than in other years, and hypothesized that the deflection resulted from vessel operations at Camp Lonely, within the Northeast NPR-A (G. Ahmaogak, pers. comm.). Bowheads shift between inner shelf and coastal waters and outer-shelf and slope waters during fall migration, apparently dependent on ice characteristics and its relationship to prey density (Moore 2000). If vessel traffic caused whales to move off-shore away from high density forage areas it could cause reduced fitness. However available evidence suggests that displacement is temporary and bowhead return to use areas after disturbance (Richardson 1995). Therefore, at least some displaced whales would be expected to return to normal (for the ice conditions) migration routes after clearing the disturbance zone of the vessel (possibly 2.5 miles or more).

Contaminant Spills

The effects of an oil spill on bowhead whales are unknown as is the relative concentration/exposure time necessary to produce and adverse effect. A detailed discussion of the potential effects of oil on whales can be found in the *Beaufort Sea Planning Area Oil and Gas Lease Sale 186, 195, and 202: Final EIS* (USDOI MMS, 2003d), pages IV-73-IV -77. This document and the subsequent Biological Evaluation for the Chukchi and Beaufort Sea OCS Leases (USDOI MMS, 2006f) document the uncertainty regarding effects oil on bowhead and the difficulty in applying information from other species. MMS (2003d) suggests that oil may act on bowhead whales through oiling the skin, inhalation, ingestion, baleen fouling, reduced prey and displacement from feeding areas, and death. In examining the available information, MMS found that support for and against such effects occurring were equivocal. MMS concluded

in their Biological Evaluation that most adult whales exposed to spilled oil would suffer temporary or permanent non-lethal effects, but that prolonged exposure to freshly spilled oil could result in death (USDOI MMS, 2006f, p 87). Impacts to newborn and very young calves may be greater.

It is unknown how activities associated with spill containment and clean up, if they were to occur outside of the nearshore habitat of Harrison Bay during the westward migration in autumn, may effect migrating bowhead whales by causing deflection and avoidance of the area, Any adverse effect is likely outweighed by the reduced potential to come in contact with spilled oil.

An oil spill resulting from development under this alternative would be unlikely to occur in the marine environment, or to reach typical bowhead whale migration habitat from onshore locations. Small spills would be very unlikely to reach marine habitats, and thus would have a minor probability of affecting bowhead whales.

Collisions

Any increase in shipping traffic related to development in Northeast NPR-A could increase the potential for collisions with bowhead whales. Alternative A could result in 150-300 barge trips over approximately 50 years in addition to the existing shipping to support other development in Prudhoe Bay and North Slope villages. The only study specifically dealing with collisions and bowhead whales was conducted by George et al (1994). They found that approximately 1% of whales harvested off Barrow had scarring consistent with contact with propellers of large ships (George et al. 1994). Whether the collisions happened in the Beaufort or Chukchi is unknown. The 1% estimate is likely biased low as whales killed by collisions were not available for harvest and sample size was relatively small compared to the population. Some evidence is provided by Laist et al 2001 that the number of whale strikes has increased as the number of ships increased worldwide, suggesting that an increase in shipping traffic could result in increased strikes (Laist et al. 2001). However, the relative number of additional vessels moving through the Chukchi and western Beaufort related to potential development under this alternative is expected to be low. In addition, barge traffic is typically slow, while most collisions causing severe injury or mortality occur when ships are traveling faster than 14 knots (~16 mph) (Laist et al. 2001). George et al (1994) concluded that ship-caused mortality was not sufficient to interfere with growth of the western Arctic stock. However, it should be noted that total vessel traffic in the Beaufort or the rest of the western Arctic stock range is unknown and may have increased in the intervening years with some increase in mortality. If so the mortality is likely low as the population continues to increase (George et al. 2004).

Commercial Gas Development

If natural gas development and production occur in the planning area, it is unlikely that bowhead whales would be affected other than temporary, nonlethal effects from marine vessels as described for traffic associated with oil development.

4.3.10.3 Effectiveness of Stipulations

Under Alternative A, lease stipulations would help prevent spilled fuel, oil, or other toxic materials from reaching the marine environment, minimizing potential effects to individual bowhead whales or the population (Lease Stipulations 1 through 17).

4.3.10.4 Conclusion

The most likely effects Alternative A would have on bowhead whales are disturbance-related. Short-term avoidance behavior including dives, direction changes, and temporary abandonment of areas may occur as the result of ship traffic or aircraft. Because the number of activities that may cause disturbance are expected to be few, limited seasonally, and generally in areas/times where whales are not concentrated, although it is unknown what lasting impacts and significant effect occur to bowhead whales as a result of disturbance from aircraft and shipping traffic. Spill analysis suggests that a terrestrial spill large enough to reach areas used regularly by bowheads is very unlikely. Inwater spills (i.e. ship accidents) cannot be discounted nor easily predicted and could have severe localized effects but are generally expected to be unlikely. Vessel strikes are the most likely impact to whales that may result in serious harm or death, but they also appear to be rare but may occur at higher frequencies if barge traffic increases in the future.

4.3.10-b Spectacled and Steller's Eiders

4.3.10-b.1 Activities Not Associated with Oil and Gas Development and Exploration

Various types of activities not related to oil and gas leasing and development, including private or commercial air traffic, aerial surveys to inventory wildlife or other resources, summer research camps, hazardous material or debris removal, subsistence hunting and fishing, and recreational camps and boating activity, could affect spectacled or Steller's eiders in the planning area. During the winter, when most birds are on wintering grounds, these activities would have no direct impact on eiders, although eiders could be indirectly impacted if their habitat is harmed. However, many of these activities would occur during the summer breeding season when eiders are in the planning area.

Aerial surveys for wildlife could include fixed-wing surveys for waterfowl and caribou, or helicopter surveys for grizzly bears and caribou. These surveys could cause temporary displacement of some eiders from feeding, nesting, or brood-rearing habitats, but would not be likely to have population level effects.

Aircraft use associated with mobilizing and re-supplying summer camps could disturb eiders along continually-used flight corridors and near airstrips during take-offs and landings. Helicopter or fixed-wing aircraft could also be used for clean-up activities at abandoned sites in the planning area, which could affect eiders. These activities could be intermittent or occur on a regular basis. The potential effects of this type of visual and noise disturbance would range from temporary displacement from preferred habitats to nest abandonment. Cumulative impacts of aircraft disturbance of all types is of concern for spectacled and Steller's eiders.

Various types of disturbances could affect eiders near summer camps. Noise and ground activity could disturb feeding, nesting, brood-rearing, molting, and staging birds, causing temporary or permanent displacement from feeding or nesting areas and potentially affecting the bird's energy budget and success in producing young. Disturbance to eiders from aircraft traffic and camp activities would likely be greatest within approximately 2,300 feet of the camp, and have little or no effect beyond 6,500 feet (Johnson et al. 2003b). Eiders nesting near summer camps could suffer mortality or egg loss from predators attracted to anthropogenic sources of food at camps. However, the lease stipulations under Alternative A would require proper handling of

food and waste to eliminate predator attraction to areas of human activity. If possible, summer camps should be located in areas away from habitats used by spectacled and Steller's eiders.

Subsistence hunting would obviously result in the mortality of eiders taken during spring or fall hunts, as well as potential loss of eggs due to collection. Other subsistence hunting and fishing activities could cause disturbances in areas where activities occurred. Summer boat traffic could occur on the Colville, Kogosukruk, Kikiakrorak, and Ikpikpuk rivers for recreational or subsistence activities, or to re-supply camps along these rivers.

4.3.10-b.2 Oil and Gas Exploration and Development Activities

Effects of Disturbances

Visual and Noise Disturbance

Seismic

Because seismic surveys to collect geological data and exploration drilling activities would occur during the winter months when eiders are not present in the planning area, these activities would have no direct impacts on eiders. Rolligons and track vehicles used during seismic exploration could leave tracks on tundra habitats that would be observable for a number of years. These types of disturbances would likely affect wet areas less than dry areas (Walker 1996), and impacts to eiders would probably be minimal. Indirect impacts associated with ice-road construction and its effect on tundra vegetation would also be unlikely to affect eiders. In some cases, equipment would be stored on ice pads that are specially designed and constructed to last through the summer and into the following winter. The tundra under the footprint of these ice pads would be lost as feeding, nesting, or brood-rearing habitat during the course of that season.

Predators attracted to anthropogenic sources of food or shelter could cause increased predation pressure on eiders near facilities. However, Lease Stipulations 2 and 3 would require proper handling of non-hazardous waste to avoid human-caused changes in predator populations. This policy has apparently been successful at the Alpine field, where Johnson et al. (2003b) reported no increase in the numbers of most predator species after development. The one exception was common raven, which became more common and nested at the Alpine field after development. However, ravens were never observed predating camera-monitored spectacled eider nests in the area surrounding CD-1, although these monitored birds likely represent a small proportion of the surrounding population (Johnson et al 2003b).

Development and Production

Activities related to oil development and production in the planning area, such as vehicle, aircraft, pedestrian and boat traffic, routine maintenance activities, heavy equipment use, oil-spill clean-up activities, and surveys to monitor eider populations could cause disturbances that would affect threatened eiders in the vicinity of gravel roads and pads. The effects of these types of disturbances, which are discussed for other waterfowl in **section 4.3.8, *Birds***, could result in temporary displacement from preferred foraging, nesting, and brood-rearing habitats, decreased nest attendance or nest abandonment, and increased energy expenditures that could affect the physiological condition and rate of survival or reproduction. The potential for the various sources of disturbance to impact eiders would depend on the location of the disturbance, the number of individuals in the area, and the time of year. Under Alternative A, development

would not occur in the areas with the highest concentrations of spectacled eiders in the wetland habitats north of Teshekpuk Lake.

Most construction activities, including pipeline installation, gravel mining, and placement for oil field infrastructure (airstrips, and pads, camps, staging areas, and processing facilities), would be conducted during the winter when eiders are not present in the planning area. During the summer, eiders could be subject to disturbances associated with vehicular and pedestrian traffic, and noise from equipment on roads or at facilities, including large trucks hauling cranes and other equipment, and road maintenance equipment on access roads and pads. No studies have been conducted to determine how these types of disturbances would affect spectacled or Steller's eiders; however, it is reasonable to assume that effects would be similar to those described for other waterfowl. These types of disturbances have been shown to have greater effects on geese feeding within 160 feet of roads than on geese feeding further away, although some disturbance could occur as far as 685 feet away (Murphy et al. 1988; Murphy and Anderson 1993). Disturbances would occur most often during the pre-nesting period when birds gather to feed in open areas near roads, and during brood-rearing and fall staging when some geese exhibit higher rates of alertness (e.g., "heads up" behavior) in areas near roads than in undisturbed areas. A small percentage of birds could walk, run, or fly to avoid vehicular disturbances (Murphy and Anderson 1993).

Pedestrian traffic could have a greater impact than vehicular traffic on some birds. During a study of the effects of disturbance related to the Lisburne Development in the Prudhoe Bay oil field, Murphy and Anderson (1993) reported that of the more common sources of disturbance, humans on foot elicited the strongest reactions from geese and swans. Johnson et al. (2003b) reported that aircraft and pedestrians elicited higher responses by nesting geese at the Alpine field than other sources of disturbance (vehicles). Restricting or reducing the level of foot traffic on gravel roads and pads could help to reduce the potential for disturbance to foraging, nesting, or brood-rearing eiders.

Air-Traffic

Both fixed-wing aircraft and helicopters could be used to transport personnel, supplies, and equipment to airstrips or staging areas during development and production activities in the planning area. The potential for disturbance to waterfowl from aircraft is well documented (Schweinsburg 1974; Ward and Stehn 1989; Derksen et al. 1992; McKechnie and Gladwin 1993). Johnson et al. (2003b) conducted the most thorough study of aircraft disturbance to waterfowl in the Arctic at the Alpine field in the Colville River Delta. Such disturbances may displace birds from feeding habitats and negatively impact energy budgets. Gollop et al. (1974b) suggested that helicopters may be more disturbing to wildlife than low-flying fixed-wing aircraft, although Balogh (1997) indicated that fixed-wing aircraft flown at 150 feet AGL often caused spectacled eiders to flush, while helicopters flown at similar altitudes in the vicinity of Prudhoe Bay did not. Under Alternative A development would be prohibited in the wetland habitats north of Teshekpuk Lake, where the highest concentrations of spectacled eiders occur, and most aircraft overflights related to oil and gas development in this area would be rare and likely be at altitudes sufficiently high to avoid disturbance to eiders. Aircraft disturbance could affect eiders in portions of the planning area open to development, although under Alternative A the effects of aircraft disturbance would likely be reduced compared to other alternatives.

The Alpine field avian monitoring program in the Colville River Delta was a multi-year project designed to identify the potential effects of noise and disturbance from aircraft, vehicle, and pedestrian traffic on birds nesting near the airstrip and on large waterbirds during brood-

rearing (Johnson et al. 2003b). Pre-nesting spectacled eiders are expected to react to disturbance similar to other waterfowl (Johnson et al. 2004). When compared to pre-construction numbers, the overall number of waterfowl nests near the airstrip declined in the area within 3,250 feet of the airstrip after construction began (Johnson et al. 2003b). However, the number of post-development nests increased in the area between 3,250 and 5,000 feet from the airstrip. The decline could not be directly linked to disturbance, as other factors, such as lower temperatures and more severe flooding later into the breeding season during construction years, may also have influenced nest densities. During years of heavy construction, white-fronted goose nest sites were apparently displaced to habitats similar to those used prior to construction, but located further from the airstrip. Johnson et al. (2003b) suggested that white-fronted goose nesting habitats in the Alpine field area had not been saturated with nests prior to development, and that nesting habitat was available in areas away from the airstrip. Proximity to the airstrip apparently did not affect nest success; successful white-fronted goose nests had a tendency to be closer to the Alpine field airstrip, the flight path, and the nearest gravel than unsuccessful nests, although most comparisons were not statistically significant. Successful waterfowl nests located near aircraft activity were also documented by Johnson (1984), who reported that at least three successful common eider nests were located within 1,000 feet of a helicopter pad on Thetis Island that averaged approximately 12 trips per day. Although there would be the potential for displacement of some eiders nesting near routinely used aircraft landing sites as a result of numerous overflights, landings, and takeoffs, some eiders would likely habituate to routine air traffic.

ConocoPhillips Alaska, Inc (CPAI) funded studies specific to spectacled eiders at the CD-3 satellite to Alpine similar in methodology to those conducted at the Alpine CPF (Johnson et al. 2003). First year results indicate that spectacled eider nest density and reproductive success were not impacted by construction activities which include a high number of rotary and fixed wing flights (Johnson et al. 2006). The authors do caution that sample size remains low. No spatial change (avoidance) by pre-nesting spectacled eiders of the CD-3 area or the Alpine facility was detected; however the total number of pre-nesting spectacled eiders detected in a larger study area including CD-3 and the Alpine CPF has been declining (Johnson et al. 2006).

Low-level helicopter survey flights to monitor pipelines for potential oil spills or leaks could also disturb threatened eiders. Routine flights would be of short duration and limited to a particular area, and would likely cause minimal disturbance. However, temporary displacement from preferred feeding habitats or brood-rearing habitats could affect the energy budgets of some eiders, and incubating eiders could be temporarily displaced from nests, which could increase the chance of eggs being predated.

Watercraft

Several types of watercraft could be used during the summer for transportation of equipment and supplies and for oil spill response training drills. Summer barge traffic with the potential to temporarily displace molting eiders, could occur in offshore waters of the planning area from mid-July through October. Displaced eiders would probably move to adjacent habitats or return to original habitats after barges pass though the area. Most of the area adjacent to the coastline would be unavailable to oil and gas leasing under Alternative A, and the potential for barge traffic to displace eiders in offshore habitats would likely be lower than under Alternatives B, C, and D.

Oil spill response training activities using watercraft could be conducted on rivers and lakes several times during the summer open-water season. The vessels used would likely be small

maneuverable crafts, suitable for work in shallow waters. Spill response training activities would have the potential to disturb foraging, nesting, or brood-rearing eiders. Boat activity could cause alert postures, disruption of feeding behavior, and flight in waterfowl, shorebirds, and raptors (Burger 1986, Belanger and Bedard 1989, Steidl and Anthony 2000). Rodgers and Smith (1995) and Rodgers and Schwikert (2001) determined the required setback distances for minimizing the potential for boat disturbance to various bird groups. Suggested buffer zones around areas of activity ranged from 325 feet for shorebirds to 600 feet for wading birds. Establishing buffer zones around known areas of eider activity during oil spill response-training activities, or conducting these activities in areas not frequented by eiders, could help to reduce negative impacts.

Habitat Loss and Alteration

Gravel mining and placement for the construction of oil field infrastructure would have the greatest potential to result in the loss of eider habitat. The potential long-term impacts associated with habitat loss could be minimized by locating gravel roads, pads, airstrips, and mine sites away from areas with high concentrations of eiders. Habitat studies and eider surveys conducted in areas proposed for development prior to the establishment of gravel mine sites and construction of roads could identify areas that are important to threatened eiders. Under Alternative A, Lease Stipulations 39 to 41 would provide for setbacks from lakes in the Deep Water Lakes Area south of Teshekpuk Lake within which permanent oil facilities would be prohibited. Although these lease stipulations were designed primarily to protect fish habitat, they may also help to mitigate potential impacts to adjacent eider habitats.

Under the development scenario for Alternative A, the gravel footprint for roads, pads, airstrips, staging areas and gravel extraction sites is estimated to be approximately 3,270 acres. Loss of eider habitat would be permanent in the area occupied by the development footprint, and eiders nesting in this area would be displaced to other areas. If spectacled and Steller's eider densities are assumed to be 2.0 and 0.02 birds per mi^2 (640 acres per mi^2) respectively (relatively high estimates based on aerial survey data; Larned et al. 2006; Ritchie and King 2003), up to 10.3 spectacled eiders and 0.1 Steller's eider could be expected to be displaced by the gravel footprint if all development occurred in high density areas. This estimate is likely overly-conservative as areas of "high high" density make up only a small proportion of the planning area (Map 3-33).

Under Alternative A, it is likely that fewer eiders would be impacted by development than under Alternatives B, C and D, because development would not be permitted in the area with the highest concentrations of spectacled eiders in the wetlands north of Teshekpuk Lake. Average eider density over 15 years in area north of Teshekpuk Lake is $0.79/mi^2$, which is greater than the long-term average for the entire eider breeding population survey area average density of $0.57/mi^2$ and is the highest density strata within the Northeast NPR-A Planning Area. This area also contains approximately 57% of the indicated population within the Northeast NPR-A Planning Area (FWS, unpublished data). Because of the closure of the area north of Teshekpuk Lake under these Alternative, impacts to spectacled eiders are expected to be much lower then the total acre impact estimate would suggest since eiders occur at greater density ($0.79/mi^2$ versus $0.212mi^2$) in the closed area than in the remaining planning area

However, under all alternatives, the potential effects of habitat loss would depend on the location of the development, the types of habitat lost, and the level of eider use in the areas to be developed. Without specific information on the locations of potential developments, the estimates of eiders potentially impacted should be seen as an index of comparison between alternatives, not an absolute value of birds affected.

In addition to permanent habitat loss, temporary loss of habitat associated with gravel placement could occur on tundra adjacent to gravel structures, where accumulated snow from snow plowing activities or snow drifts would become compacted and cause delayed snowmelt. Delayed snowmelt persisting into the nesting season could preclude eiders from nesting in those areas.

Dust deposition could affect eider habitat by causing early green-up on tundra adjacent to roads and pads, which could attract eiders and other waterfowl early in the season, when other areas were not yet snow free. Traffic levels, air traffic (including helicopters), and wind can all influence the amount of dust that may be deposited adjacent to roads and pads.

Impoundments created by gravel structures could cause temporary or permanent flooding on adjacent tundra. Impoundments could be ephemeral, drying up early during the summer, or they could become permanent water bodies that would persist from year to year (Walker et al. 1987a, b; Walker 1996). Tundra covered by impounded water could result in a loss of nesting habitat for some birds. However, impoundments could also create new feeding and brood-rearing habitat that would be beneficial to waterfowl, including eiders. Noel et al. (1996) reported that the areas occupied by impoundments in the Prudhoe Bay area generally supported higher waterfowl densities than the same areas did prior to development, and that spectacled eiders nested on some impoundments. Warnock and Troy (1992) and Anderson et al. (1992) also reported use of impoundments by spectacled eider in the Prudhoe Bay and Kuparuk oil fields. The effects of impoundments could be minimized or eliminated with engineering plans that provided culverts to allow for adequate cross-drainage at gravel structures. However, culverts blocked by snow or ice could prolong the spring flooding period (Walker 1996).

Mortality

Eider mortality could result from road kills due to collisions with vehicular traffic. Within the TAPS, roadkills were the greatest source of bird mortality, particularly along the Dalton Highway where dust shadows caused early green-up along the road that attracted birds (TAPS 2001). However, spectacled eiders are primarily aquatic foragers (Petersen et al. 2000) and are unlikely to be attracted to near road areas because of terrestrial vegetation phrenology; but they may move into early meltwater ponds adjacent to roads, possibly increasing collision risk. In addition, eiders are mobile and will move broods between lakes and are low elevation fliers, so collisions are possible. The relatively lower amount of development under this Alternative compared to Alternatives B-D would indicate a relatively lower level of potential impact.

Some earlier mortality could also result from collisions with structures such as elevated pipelines, buildings, towers, boats, or bridges. Quakenbush and Snyder-Conn (1993) reported that a female Steller's eider was apparently killed by a collision with an observation tower at Nanvak Bay near Cape Pierce, Alaska. Lovvorn et al. (2003) salvaged three spectacled eiders that collided with a ship during the predawn hours in the Bering Sea. Eiders have also apparently been killed after striking transmission lines or guywires in Barrow and Prudhoe Bay (USFWS 2005). However, visibility is generally good during long summer daylight hours in the Arctic, and collision has apparently been only a minor source of bird mortality associated with the TAPS (TAPS 2001). The biggest risk period would be to females with broods in the fall during staging when there is a higher potential of poor visibility due to storms.

Some predators, such as ravens, gulls, Arctic fox, and bears, would be attracted to areas of human activity where anthropogenic sources of food and denning or nesting sites were present (Eberhardt et al. 1982, 1983a, b; Day 1998; Burgess 2000). Increased levels of predation due to

greater numbers of predators could in turn impact nesting and brood-rearing eiders. Major negative impacts have occurred at the Howe Island goose colony in the Sagavanirktok Delta from predation by Arctic fox and grizzly bears (Johnson 2000a), and Arctic fox and glaucous gull are predators of common eider and brant eggs and young on the barrier islands (Noel et al. 2002). Arctic fox predation can also impact tundra nesting shorebirds and passerines (Day 1998, Rodrigues 2002). In recent years, oil field operators have installed predator-proof dumpsters at camps and implemented new refuse handling techniques. At least through construction these methods have apparently been successful. No increase in fox den density or reproductive success was noted through construction of the Alpine CPF (Johnson et al. 2003). However, the study only included the period through completion of construction and operational activities, therefore it is unknown if activities after this time period have resulted in a change in fox den density or reproductive success.

Contaminant Spills

Oil spills or leaks onto tundra or marine habitats could negatively impact spectacled or Steller's eiders in numerous ways. Oil could come in contact with and adhere to feathers, causing the feathers to lose their insulating capabilities and resulting in hypothermia (Patten et al. 1991). This effect would be particularly severe for birds that come in contact with water where feather integrity is necessary to maintain water repellency and buoyancy, and could have more severe consequences in marine habitats than in terrestrial habitats. Birds could also suffer toxic effects from ingestion of oil by consumption of food contaminated by an oil spill or from oil ingestion resulting from preening of oiled feathers (Hansen 1981). Oil contacting with bird eggs could cause toxic effects to embryos (Patten and Patten 1979, Stickel and Dieter 1979). Oil could come in contact with eggs directly as a result of a spill, or indirectly from oiled feathers of incubating adults.

Topographical features could confine oil spills and leaks from pipelines located in terrestrial habitats. Spilled oil could also enter a lake or pond and be contained by the banks of these waterbodies. However, during spring flooding, an oil spill could spread to a much larger area, depending on the amount of oil spilled, surface topography, and the extent and duration of flooding. Oil entering a river or stream would have the potential to spread into delta or coastal areas, where impacts to birds could be more severe. Under Alternative A, Lease Stipulation 39 would help to mitigate potential impacts to eiders from an oil spill by providing setbacks of ½ to 3 miles from specified rivers, within which permanent oil facilities would be prohibited. McDonald et al. (2002) conducted an oil spill risk assessment for spectacled eiders in the Prudhoe Bay area, using scenarios constructed to mimic spills that had occurred on lake and tundra habitats in the Prudhoe Bay oil field. Based on the assumptions of these scenarios, a maximum of 0.1 spectacled eiders would be exposed to oil from an aquatic spill covering 185 acres, and 0.02 spectacled eiders would be exposed to oil from a tundra spill covering 24 acres.

In marine habitats, wind and currents would have the potential to spread an oil spill over a larger area than in under most terrestrial habitats; therefore, molting eiders in marine habitats could be particularly susceptible to the negative impacts of an oil spill. Under Alternative A, offshore development is not proposed for the planning area; however, a potential spill from an onshore source could spread to offshore areas, or a tanker spill could occur in offshore waters. A spill occurring during the summer breeding season would have a greater impact on threatened eiders than a spill occurring during the winter, when eiders are on wintering grounds. However, lingering effects from a winter spill could impact eiders during the following breeding season if clean-up activities did not adequately remove contaminants from bird habitats, such as open leads that are used by eiders during spring migration. An oil spill spreading into offshore

waters of Harrison Bay during the fall molting/staging period would have the potential to affect a greater number of spectacled eiders than a nearshore spill (Fischer et al. 2002). Stehn and Platte (2000) developed an oil spill scenario for the central Beaufort Sea for the proposed Liberty Project based on a spill size of 5,912 bbl. When taking spectacled eider densities in the Beaufort Sea into consideration, the highest mean number of spectacled eiders exposed to oil was two birds. There is some evidence, however, that spectacled eiders can occur in flocks in offshore Beaufort Sea habitats (Fischer et al. 2002). Under such a scenario, an offshore spill could impact more birds than predicted by Stehn and Platte (2000).

Commercial Gas Development

Gas development would have impacts on eiders similar to that described for oil development, except that there would be no impacts from oil spills. Any effects of natural gas development and production on spectacled and Steller's eiders are expected to be limited to temporary, nonlethal effects, perhaps resulting in disturbance to a few birds. However, a natural gas well blowout occurring from June to September could affect eiders that are nesting, rearing young, staging, or migrating. Some mortality could result from such an incident, although it is likely that no more than a small number of individuals would be affected. Such impacts to eiders would be more likely in alternatives B, C, and D, which make lands available for leasing north and east of Teshekpuk Lake than Alternative A.

4.3.10-b.3 Effectiveness of Stipulations

Under Alternative A, lease stipulations would help prevent spilled fuel, oil, or other toxic materials from reaching the marine and freshweater environment, minimizing potential effects to eiders (Lease Stipulations 1 through 17). Eiders would benefit from lease stipulations to ensure protection of vegetation used for nesting, cover, and foraging (Lease Stipulations 18 and 24), and aquatic habitats (Lease Stipulations 21, 31, 39, 41, and 46). Eiders would also benefit from lease stipulations designed to reduce or prohibit activities that could disturb the birds, including seismic operations and aircraft activities (Lease Stipulations 24, 53, and 57).

4.3.10-b.4 Conclusion

Spectacled and Steller's eiders may be affected by oil and gas leasing and development in the planning area. Activities related to oil and gas development and production such as vehicle, aircraft, pedestrian and boat traffic, routine maintenance activities, heavy equipment use, facility noise, and oil spill clean-up activities could cause disturbances that affect eiders. Permanent habitat loss would result from gravel placement for roads and pads, and at gravel mine sites. Temporary habitat loss or alteration may occur in areas adjacent to gravel roads due to snow and/or dust deposition, thermokarst, and the formation of impoundments. Eider mortality could result from collisions with vehicular or vessel traffic, or collisions with towers, buildings, pipelines, bridges, or other facilities. An oil spill also could impact eiders on terrestrial or marine habitats.

The expected number of fields and the level of development under Alternative A would be reduced compared to the other alternatives and the potential effects of disturbance, habitat loss and alteration, and mortality to spectacled and Steller's eiders due to development under this alternative would likely be reduced compared to other alternatives.

4.3.10-c Polar Bear

4.3.10-c.1 Activities Not Associated with Oil and Gas Exploration and Development

Subsistence hunting and disturbance of denning bears resulting from winter overland travel likely have the most effect on bears in planning area. There is no record of where bears are taken, so the how subsistence take impacts bears in or near the planning area is unknown, but on average 32 bears from the Southern Beaufort Sea stock are taken annually in Alaska (Angliss and Outlaw, 2005). Winter overland travel not in support of oil and gas is likely relatively rare in the planning area and unlikely to result in significant disturbance effects. Research activities and close passes (<1 mile) may cause abandonment of a den if they occur early in the season but do not appear to have significant effects later in the season (Amstrup, 1993).

4.3.10-c.2 Oil and Gas Exploration and Development Activities

Seismic

Under Alternative A, seismic surveys conducted near the coast could expose a few denning polar bears to noise and associated disturbances. This disturbance could result in the displacement of a few maternal polar bears and their dependent cubs, leading to the abandonment of the den site and possible death of a small number of cubs. However, relatively few polar bears would be affected because of the low number of recorded maternal den sites in and adjacent to the planning area. Lease stipulations prohibit seismic surveys within one mile of known or suspected polar bear dens.

Exploration

Exploratory drilling near the coast during winter (December to mid-April) would potentially disturb, displace, or attract polar bears. Female polar bears denning within one mile of the construction activity could be disturbed by vehicle traffic or construction noise. Disturbance of females in maternity dens could result in abandonment of the cubs or premature exposure of cubs (Amstrup 1993). Few dens have been reported in the planning area in the last 10 years (Map 3-29), although bears are known to occasionally den in the area. Lease Stipulation 24(a) requires that industrial activities maintain a 1-mile buffer around known or suspected polar bear dens. MacGillivray et al.(2003) measured noise from industrial activities in the air and within artificial polar bear dens at varying distances from the activity. Noise within the dens from vehicle traffic was generally attenuated to background levels when vehicles were approximately 1,600 feet away. In addition, most polar bear dens are off the coast of the northern portion of the planning area, which is closed under this alternative. Thus, it appears that current lease stipulations would be sufficient to minimize disturbance to polar bears in natal dens.

Development and Production

Female polar bears denning within approximately one mile of construction activity could be disturbed by vehicle traffic and construction noise, which could result in the abandonment of the den and the potential death of cubs (Amstrup 1993). The number of bears affected would depend on the number of undetected dens located within the 1-mile buffer around construction

activity. The severity of the effect would depend on the reaction of individual bears, whether the den was active or abandoned, and the age of the cubs when the disturbance occurred.

Denning polar bears could be disturbed, and mortality caused to cubs if they are abandoned or prematurely exposed to adverse weather conditions, by activities within about 1 mile of their dens if these dens were not detected and disturbance avoided as required by lease stipulations.

Some polar bears could be attracted to oil field camps by food odors and curiosity. Attraction to the area would increase the potential for human-bear interactions, and could result in intentional harassment or death of the bear in defense of human life or property. However, such actions have been rare in the past, and should not be common in the planning area. Workers would be required to participate in bear-awareness training programs (Lease Stipulation 63), and Lease Stipulations 76 and 77 have been established that would minimize the potential for polar bear interaction with humans. Consultation between oil field developers and the USFWS should result in the use of nonlethal means of deterrence in most cases. Therefore, the number of bears lost as a result of such encounters is expected to be minor and not result in population impacts (USFWS 2007).

Contaminant Spill

Polar bears are known to travel and den along the Colville River and would be most vulnerable during fall (open water), winter, and spring months. Oil has been documented to be highly toxic to polar bears (Oritsland et al, 1981. Polar bears may be affected directly through contacting spilled oil or ingesting contaminated prey (Pristland et al. 1981; Stirling 1990), or indirectly through loss of habitat or prey species. However, the low probability of a very large oil spill combined with the likelihood of low numbers of bears occurring in the area suggests that population-level effects would likely be minor, unless spilled oil traveled extensively into the marine environment, or aggregations of bears encountered oil.

Female polar bears select "bluffs" including river banks for denning habitat, thus they are more likely to be present in river drainages. Any spill that reached a river during late fall when polar bears are constructing dens, occurred in winter under ice, or in spring during broken ice periods could impact denning polar bears and their young if the spill was large enough to reach the den area.

Spring or summer spills that reached marine waters would have the greatest likelihood of impacting polar bears or their prey. Spills during broken ice or in the lead system would have the largest potential for adverse effect.

In certain areas polar bears congregate in large numbers to take advantage of whale carcasses brought ashore by subsistence hunters. Areas of concentration include Point Barrow, Cross Island, and Kaktovik (USDOI, FWS, 1999). More than 60 polar bears have been observed feeding on whale carcasses just outside of Kaktovik (Miller, 2006), and in the autumn of 2002, North Slope Borough and FWS biologists documented more than 100 polar bears that came ashore in and around Barrow (USDOI, FWS, pers. comm. Cited in MMS 2006). None of these areas are within the planning area. In most other areas polar bears are generally widely dispersed (Amstrup, 1986; Amstrup et al., 2000), thus any spill would be unlikely to affect more than one to three bears.

Effects of Abandonment and Rehabilitation

Effects would generally be the same as under construction. Dismantling of equipment and modules and readying it for transport would most likely take place during summer. Transport of large or heavy material would be a winter activity and occur over ice roads. Any re-contouring or removal of gravel would primarily be done in the winter, although some summer activity may be necessary to complete rehabilitation efforts. Any planting or monitoring would also be conducted in the summer. A combination of surface vehicles and aircraft would be required for transportation. The potential for large spills would be substantially reduced after shut-down of oil and gas operations.

Abandoned pads or their remnants may provide topographic relief that catches snow and provide denning substrate; possibly increasing terrestrial denning availability. This effect is likely to be negligible, however.

Commercial Gas Development

If natural gas development and production occur in the coastal areas used by polar bears, potential impacts would include those described above for oil development, such as attraction to waste from the facilities, though there would be no oil spill impacts. Denning female bears may be encountered during winter construction or maintenance activities. Aroused female bears may abandon the den, potentially leaving cubs. Additionally, increased energy expenditure could negatively impact the cub survival.

4.3.10-c.3 Effectiveness of Stipulations

Under Alternative A, lease stipulations would help prevent spilled fuel, oil, or other toxic materials from reaching the marine environment, minimizing potential effects to polar bears or their prey (Lease Stipulations 1 through 17). Polar bears would also benefit somewhat from lease stipulations designed to reduce or prohibit activities that could disturb the birds, including seismic operations and aircraft activities (Lease Stipulations 24, 53, and 57).

4.3.10-c.4 Conclusion

The potential for impacts to polar bears under Alternative A is low. The area where most denning polar bears are likely to be found is closed to development. Avoidance requirements should substantially reduce the potential of disturbance to bears denning in other areas and good management practices reduce the potential for human-bear interactions. Although an oil spill could impact bears or their prey, the likelihood of a large enough spill to reach the marine environment in sufficient concentration to have adverse impacts is very low. Further, bears are typically widely dispersed, so impacts would only occur to a few bears.

4.3.11 Cultural Resources

4.3.11.1 Activities Not Associated With Oil and Gas Exploration and Development

Aircraft and watercraft traffic, scientific investigations (e.g., archaeological, paleontological, and geological survey and excavation), summer camps, hazardous and solid waste material removal

and remediation, overland moves and recreation associated with non-oil and gas activities would all have effects on cultural resources. Aircraft use would not directly affect cultural resources; however, it could have an indirect effect by making cultural resources more accessible to recreation and other users. Watercraft can also provide easy access to cultural resource locales.

BLM and BLM permittees conduct archaeological, paleontological, and geological research, survey and excavation within the planning area. Surveys (pedestrian and aerial), excavation, and collection generally occur during the summer. Survey personnel often encounter cultural resources by chance because they are generally located on or near the surface. While excavation and collection are destructive activities, they are necessary for the recovery of scientific data.

The temporary summer field camps commonly associated with scientific research or resource assessment generally affect small areas for one to several summers. Larger camps would most likely be located at the Inigok airstrip, Point Lonely DEW-Line site, or the Ivotuk airstrip. These sites would use existing gravel pads where available, and low-impact camp practices elsewhere. It is possible that larger camps would affect undocumented cultural resources. However, these camps have been in place for some time, and previous research and surveys should have already identified any cultural resources near these camps. Therefore, temporary camps and the activities that are associated with them, such as aircraft use, on-the-ground survey and reconnaissance, hazardous and solid-material removal and site remediation, and recreation, would not have any discernable effect on cultural resources.

Prior to or during ground disturbing activities, qualified cultural resources personnel would determine if cultural resources exist on the site and monitor hazardous and solid waste material removal and remediation. Determinations of National Register of Historic Place eligibility would be, and have been, conducted for sites undergoing hazardous and solid waste material removal and remediation to determine whether the sites being cleaned up are themselves archaeologically and historically important (e.g., Point Lonely DEW-Line site, Planning Area exploration camps, pioneer exploration pads, and wells). Cultural resource monitoring and clearance would occur during the discovery, site verification, risk assessment, and site evaluation stages, if ground-disturbing activities were to occur.

BLM regulates non-oil and gas related overland moves, which only occur during the winter when there is adequate snow cover and depth of frozen ground, or when ice roads are present. It is possible that damage would occur to known or unidentified cultural resources in the planning area. The prevalence of shallow and surface level cultural resources in the planning area suggests that undocumented cultural resources could be damaged even using the best available practices. Since non-oil and gas-related overland moves are not numerous in the planning area, however, they would have minor impact on cultural resources.

Recreational use of the planning area primarily includes summer use by birdwatchers and rafters. Given the importance of waterways to prehistoric and historic peoples for transportation and subsistence, cultural resources are concentrated along these corridors and may be exposed by erosion over time. Therefore, recreational users camping on riverbanks and bars could affect these resources as a result of boating activities, and through unauthorized collecting of cultural resources found along waterways or near camps.

4.3.11.2 Oil and Gas Exploration and Development Activities

Because gathering of seismic data is permitted only during the winter using low-ground-pressure vehicles (Lease Stipulation 24[f]), it is unlikely that this activity would effect undocumented subsurface cultural resources. However, use of seismic vehicles could result in the damage or destruction of surface cultural resources. In general, permittees can visually detect and subsequently avoid most surface cultural resources, which are usually structures of some type, even when these resources are covered by snow. Snow cover and frozen vegetation would protect other surface cultural resources, such as isolated artifacts, from vehicle crushing. An exception could be human skeletal remains that lie on the ground surface and may not be protected from vehicle crushing by snow cover.

It is worth noting that cultural resources are not as widespread as wildlife and vegetation. As a result, oil and gas exploration or development activities would have a minor effect on cultural resources, because permittees could conduct oil and gas activities to avoid the locations of identified cultural resources. However, as modern users tend to use the same areas used by prehistoric and historic Iñupiat, such as high, dry ground along rivers, streams, and lakes, minor damage to resources in these areas could occur.

Effects of Disturbances

Under Alternative A, exploration and development activities in the planning area would be conducted on existing leases, outside the areas excluded by withdrawals and lease stipulations listed in the 1998 Northeast IAP/EIS ROD. However, because most of these activities would occur during the winter months, the potential for effects to subsurface cultural resources would be minor.

Disturbances associated with development activities (i.e., the construction of production pads connected by roads, airstrips, staging bases, and pipelines) could affect cultural resources under Alternative A. This type of development would be most likely to affect cultural resources through the excavation of material (e.g., gravel) for the construction of permanent facilities, as the location of terrestrial gravel sources often coincides with the location of cultural resources. Placement of gravel for pads, roads, and airstrips could potentially alter or destroy cultural resources. Pre-construction assessment and monitoring under Lease Stipulations 64 and 74, as well as under the NHPA, would identify the location and extent of nearby cultural resources. The placement of VSMs during pipeline construction could also affect buried cultural resources in the planning area, depending on the depth at which the VSMs were set. The excavation and burial of pipelines could also alter or destroy subsurface resources, depending on the depth, size, and location of the pipeline.

Effects of Abandonment and Rehabilitation

It is unlikely that cultural resources would be impacted by abandonment activities unless the facilities to be abandoned or removed during rehabilitation were themselves historic.

Effects of Spills

In the exploration stage, most spills would occur on an ice pad or ice road and during winter conditions. In such a case, the spill or subsequent spill cleanup would most likely not alter or destroy buried cultural resources, but could affect surface cultural resources by covering these resources with oil or other spill material. If the oil is warm enough, however, it could melt

through the snow and melt the ground and impact cultural resources buried near the surface of the ground. A spill occurring during the summer would have a greater potential to affect surface and subsurface cultural resource sites than a spill occurring during the winter because the effects of both the spill and subsequent cleanup would be greater. Oil spills on cultural resource sites would cause damage proportional to the extent of contamination, and could require data recovery (excavation) as part of remediation and clean-up efforts. However, irreparable damage to some of the data could occur. Oil spills at cultural resource sites, either surface or buried, would make radiocarbon dating of that site problematic or impossible. The spilled oil would seep into charcoal, bone, wood, or other materials used for radiocarbon dating, and contaminate them so that their true dates would no longer be possible to accurately determine.

Commercial Gas Development

If commercial gas development occurs and gas pipelines are buried, disturbance of, and potential alteration or destruction of cultural resources could occur during excavation and burial of the pipelines. A 162-mile pipeline buried in a 4-foot-wide trench would involve excavation of 80 acres and surface disturbance during pipeline construction of approximately 210 additional acres. The risk of impacts to cultural resources would be reduced dramatically if gas pipelines are put on VSMs rather than buried. In such a situation, cultural resource impacts would be extremely low—limited to approximately 1.5 acres impacted by the VSMs themselves (assuming a separate set of VSMs are needed rather than using the VSMs associated with oil transportation) and disturbance associated with building a 10- to 20-acre compressor pad.

4.3.11.3 Effectiveness of Stipulations

Under Alternative A, several lease stipulations would minimize the effects of oil exploration and development activities on cultural resources. Lease Stipulation 24 addresses overland transportation and restrictions on ground surface disturbance, and would potentially protect subsurface cultural resources by requiring that operators use low-ground-pressure vehicles and cease operations when the spring melt of snow begins. Lease Stipulation 26 prohibits exploratory drilling within 1,200 feet, and Lease Stipulation 47 prohibits permanent oil and gas facilities (with the exception of pipelines) within 1 mile, of any known, long-term cabin or campsite. Lease Stipulations 39 and 62 provide for setbacks along rivers, streams, lakes, cabins, and the coast, providing additional protection for cultural resources and traditional/cultural land use areas. Lease Stipulation 63 minimizes cultural and resource conflicts through an orientation program for personnel that would include instruction on the importance of not disturbing archaeological resources and sensitivity to community values, customs, and lifestyles. Lease Stipulation 64 calls for an inventory of known traditional land use sites (NSB TLUI sites; see Appendix I) prior to any field activity so that these sites can be avoided and any damage from field activities can be mitigated. Lease Stipulation 67 mandates the avoidance or minimization of damage to vegetation, including the tundra mat, which could protect shallow sites. Lease Stipulation 74 calls for a cultural resources survey prior to any ground disturbing activity.

BLM requires permittees to complete a cultural resources survey prior to any undertaking (i.e., any ground-disturbing activity, such as the construction of buried pipelines) on Federal lands. If surveyors identify cultural resources during the survey, BLM guidelines and policy require that all potential effects to these resources be mitigated to the satisfaction of the land manager.

4.3.11.4 Conclusion

The potential exists for harm to or loss of cultural resources from non-oil and gas activities, and those activities associated with oil and gas exploration and development, but these impacts should be minor. Most impacts would be associated with ground-disturbance activities, but lessees are required to conduct a cultural resource survey prior to implementing any ground-disturbing activity.

Approximately 2 to 3% of the planning area has been surveyed for cultural resources. The distribution of known cultural sites does not reflect locational preference of prehistoric and historic people, but rather indicates that only portions of the planning area (e.g., well sites, portions of the coast, the Colville River, the Ikpikpuk River, and the Teshekpuk Lake area) have been examined through some type of organized reconnaissance for the presence of cultural sites. The TLUI sites generally cluster in these same areas with greater density on the lower Ikpikpuk River and associated drainages (NSB 1978, 2003). Activities that occur near these areas may have a greater likelihood of impacting cultural resources. In the most general terms, where surveys and inventories have been conducted, cultural sites have usually been found. Since surveys are required before any ground-disturbing activity can take place, the potential impacts to cultural resources from oil and gas exploration and development activities under Alternative A is minor. These impacts would be mitigated by lease stipulations that prohibit oil and gas exploration and development in areas with a high likelihood of having cultural resources, enforcement of lease stipulations that prohibit collection of artifacts and require training of workers regarding avoidance of effects on cultural resources, and compliance with all Federal laws, including the National Historic Preservation Act, requiring surveys for cultural resources in areas where ground-disturbing activities are proposed.

4.3.12 Subsistence

4.3.12.1 Activities Not Associated With Oil and Gas Exploration and Development

Activities not associated with oil and gas exploration and development include: aircraft and watercraft use; research activities, including remote camps associated with research; overland moves; and recreation. All of these activities have the potential to affect subsistence use. See **section 4.1** for a detailed description of the types of non-oil and gas activities that may occur in the planning area.

Effects of Disturbances

Aircraft Use

Under all alternatives, it is anticipated that there will be a certain level of aircraft activity associated with management of the NPR-A, including aircraft activity in support of research, surveying crews, or other projects. This aircraft activity includes fixed-wing surveys, such as those conducted to determine wildlife populations; point-to-point flights by both fixed-wing aircraft and helicopters; and helicopter-supported surveys. Aircraft operating under a BLM permit for non-oil and gas projects would be required to follow the stipulated altitude and activity rules; however, BLM would have no authority over private aircraft not associated with permitted activities. It is anticipated that most non-oil and gas aircraft activity would occur during the summer months in support of research or other projects; however, aircraft use could

also occur during the winter in support of remediation or clean-up work, as well as some climate research activities.

Of all non-oil and gas activities, aircraft use, especially the use of helicopters, has the potential to be the most disrupting to subsistence use in the planning area. As noted in the mammals section (see **section 4.3.9.1**), caribou show a definite response to low-flying aircraft, resulting in displacement away from the aircraft activity. Under certain conditions (e.g., insect harassment, hard or deep snow cover), aircraft activity could increase stress in these animals, possibly leading to failed breeding or even death of individuals. However, most fixed-wing flights that would occur in the planning area, including wildlife surveys, would be conducted at a sufficient altitude to minimize impacts to wildlife.

Helicopters are commonly used in support of most field activities in the planning area, as a result of the limited amount of adequate landing areas for fixed wing aircraft, and the lack of road or trail systems. Testimony from local hunters, including direct complaints to BLM and the North Slope Borough Department of Wildlife Management, indicate that helicopters frequently disrupt hunting parties by scattering and displacing caribou or other game, resulting in a missed harvest, as hunters will rarely harvest an animal that has been "spooked" due to the resulting bad flavor of the meat (USDOI-BLM SAP 2004, 2005, 2006a, 2006b). A disrupted harvest such as this results in direct impacts to the hunter in terms of lost time, effort, and resources, such as fuel. Subsistence harvesters also describe the stress that occurs when they are out hunting and hear a helicopter operating nearby, because they are never sure whether the helicopter will approach and disrupt the hunt.

Watercraft Use

Like aircraft, watercraft (e.g., airboats, outboards, jet-drive, and non-powered boats) use would be allowed in the planning area. Watercraft operations would be managed in the same fashion as aircraft, in that all BLM permitted watercraft users would be required to follow the appropriate stipulations. Non-oil and gas watercraft activities would have a localized effect that could cause subsistence species, such as caribou, to avoid the immediate area of activity (i.e., along the riverbank, or near the lake shore) or cause the short-term abandonment of habitats by waterfowl. Watercraft use is not anticipated to disrupt harvesters as much as helicopter use, both because of the limited area of effect, and the relative low-level of use. The effect on harvest patterns would be dependent on the frequency of the watercraft activity, but would most likely be a temporary and local effect on harvest patterns.

Research activities

Scientific research and data collection in a variety of disciplines (e.g., biological, geological, archaeological, and paleontological) is a frequent occurrence in the planning area. Research and data collection activities could require the establishment of temporary or semi-permanent camps; the use of aircraft, four-wheelers, or boats; and the disturbance of wildlife, vegetation, or soil. Temporary camps could cause displacement of subsistence resources from the immediate area for the duration of the camp, and could also cause harvesters to avoid the area of the camp while out hunting, so as not to discharge a weapon in the vicinity of people. The larger the camp and the longer the occupancy, the greater the potential effect to subsistence users. Wildlife attracted to camps, such as grizzly bear or foxes, could be killed as a result of defense of life and property, but not at a level that would affect the overall population or availability of these resources for subsistence harvesters.

Personnel walking on the tundra could disturb caribou and muskox to a greater degree than other activities (Murphy and Lawhead 2000). Depending on the timing of research and data collection, and its areas of effect and intensity, these activities could cause terrestrial mammals, birds, and fish to move out of areas where subsistence harvesters would anticipate them to be available, thus affecting subsistence patterns for the duration of the activities. Residents of Nuiqsut have noted a decrease in bird populations, which they attribute to foxes (SRBA 2003a, b). Scientists that observe nesting waterfowl could influence predator behavior by attracting predators to the nest. The effects of research activities on subsistence harvest patterns would be temporary and localized (e.g., limited to the camp and data collection areas).

Aircraft and watercraft use associated with research would have the same effects as those described above. Additionally, camps and or research projects that are supported by helicopter usually have a fuel cache located nearby. These caches require a permit from BLM, including requirements for containment and proper handling, and are not expected to result in an impact to subsistence resources or use. The use of ATVs or snowmobiles by researchers also has the potential to temporarily displace resources from the area of such use. However, this activity is not expected to appreciably affect subsistence harvesters, as only a very small amount of research is carried out using these types of vehicles.

Recreation

Recreational uses of the planning area include rafting and bird-watching tours conducted primarily on the Colville River by commercial guiding companies. Commercial permit holders are subject to the stipulations outlined in the 1998 Northeast IAP/EIS ROD. Non-guided rafting and bird watching tours could take place during the summer, but the frequency, duration, and intensity of this use are difficult to predict. Non-guided recreational users are not legally bound to any of the lease stipulations, but must comply with existing laws and regulations for the area. Recreational uses could disturb the movements and habitat use of subsistence species, causing a short-term, localized effect. Recreational users would likely frequent waterways shared with other users, such as subsistence hunters, potentially resulting in resource user conflicts. Non-resident hunters of Game Management Unit 26A, which encompasses the planning area, could harvest bear, caribou or moose under the state hunting regulations. However, this recreational sport hunting is limited by the lack of access in to the area, and restrictions on the timing of hunts and state bag limits. Currently, there are no hunting guides operating under a BLM permit in the Northeast planning area. Effects on subsistence harvest patterns caused by recreational users would be localized and temporary.

Solid and Hazardous Waste Removal and Remediation

Solid and hazardous waste removal and remediation, including the monitoring of existing clean-up sites and aging infrastructure (e.g., wellheads), would occur under Alternative A. This activity would involve conducting site characterizations, removal of hazardous materials, possible stockpiling of contaminated materials, and eventual disposal in an appropriate facility. Site characterizations would be completed during the summer, and access would most likely be by helicopter. This use could cause temporary and localized displacement as described above under aircraft use. Equipment to be used during the clean-up process would be moved to the area over ice roads or snow packed trails during the winter, or, depending on the location of the clean-up activity, could be barged to the area during the summer. Ice road construction, or winter movement over a snow-packed trail, could also displace resources from the route during the activity. The barging of clean-up equipment, or the resulting contaminated material could affect sea mammal and bowhead whale hunting. Site cleanup and remediation activities could

temporarily divert or disturb caribou, muskox, and grizzly and polar bears, but would have little effect on long-term subsistence harvest patterns. Long-term effects could include a decreased potential for contamination of subsistence species with the cleanup of waste sites. Given the cost of conducting this type of activity, it is unlikely that more than one clean-up would occur in any given year. Additionally, communities on the North Slope have placed a high value and fully support this type of activity (USDOI-BLM SAP 2005, 2006a, 2006b). Effects on subsistence harvest patterns by this activity would be localized and temporary.

Overland moves

Overland moves, such as supply trips to communities via rolligon, would occur only by permit and would be subject to the stipulations in the 1998 Northeast IAP/EIS ROD. These moves would only occur in the winter on frozen tundra with an adequate accumulation of snow pack, or on ice roads. Overland moves can displace or disturb caribou, grizzly bears, polar bears, muskox, wolves, and wolverines from the immediate area of the travel route. The effects of overland moves on subsistence harvest patterns would also be localized and of short duration; however, their effects on harvest patterns would increase as the frequency increased. In cases where oil and gas ice roads were used for non-oil and gas activities, increased traffic could result in additional effects on harvest patterns. These effects would last for as long as the ice road was used, and would vary depending on the intensity and frequency of traffic.

Conclusion

Non-oil and gas activities that could affect subsistence harvest patterns would include air and watercraft use, scientific research and remediation projects, recreational use, and overland moves. These activities could alter the availability of subsistence species in traditional harvest areas through direct interference with hunts. This direct interference could affect harvest patterns by requiring hunters to travel further because the subsistence resources are more wary than normal following a disturbance or are deflected from traditional harvest areas following the presence of vehicles, vessels, and aircraft. Nuiqsut residents stated in the *Alpine Satellite Development Plan EIS* that aircraft have diverted subsistence resources away from areas where hunters were actively pursuing them, directly interfered with harvests, or caused harvests to fail (USDOI BLM 2004c). Increased travel distances would result in greater expenditures for fuel and equipment as wear and tear on snowmobiles, outboards, and four-wheelers could occur. The risk of equipment failure would increase as travel distances and times increased, which could require increased search and rescue efforts by the NSB.

4.3.12.2 Oil and Gas Exploration and Development Activities

Alternative A would withhold approximately 600,000 acres from leasing and development, including a large portion of the Teshekpuk Lake Special Area. This would leave 87% of the planning area available for oil and gas leasing.

Effects of Disturbances

Seismic Survey Activity

Seismic surveys are conducted to gain an understanding of the subsurface geology of a region, in order to identify locations for exploratory drilling. Any given seismic survey covers a large area, and consists of 8-10 vehicles that travel over the tundra when conditions allow, stopping to produce a sound source that is recorded by lines of geophones strung out across the ground and

connected to 8-10 receiver vehicles. Support for the survey is provided by a mobile camp unit consisting of sleigh-mounted trailers pulled by tracked D-7 bulldozers, and assorted tracked and wheeled vehicles. The mobile camp will include a kitchen, diner, washroom, sleeping rooms, offices, generator rooms and storage areas, and is moved every few days during the operation. Under Alternative A, seismic surveys can only be conducted when frost has reached a depth of 12 inches below surface and there is six inches of snow.

Under all alternatives, it is anticipated that five additional seismic surveys, three 2-D and two 3-D, would be conducted within the planning area in order to cover all gaps where seismic has not yet occurred. The three 2-D surveys are projected to potentially impact a total of 8,126 acres, which is the combined total of acres impacted by the survey and acres impacted by the camp train overland move. The two 3-D surveys are estimated to potentially impact a total of 99,870 acres, combined. It is also assumed that the surveys would occur in those areas currently not covered by 3-D surveys, which include the foothills area and the area north and east of Teshekpuk Lake (see Figure 4.6).

Because seismic exploration by vibroseis occurs during the winter months, the primary subsistence activities that may be impacted include caribou and furbearer hunting, trapping, and fishing. Seismic activity has the potential to affect the following terrestrial subsistence resources: caribou, wolves, wolverine and polar bear. Testimony by community members from Barrow and Nuiqsut has indicated that seismic exploration does interfere with overland travel by snowmobiles (USDOI-BLM SAP 2002). Specifically, the deep ruts left in the snow by seismic vehicles freeze, creating difficult terrain to traverse, resulting in excessive wear-and-tear on both snowmobiles and the sleds that are pulled behind them. Additionally, there is the potential for a machine to become inoperable, and the need for Search and Rescue services. Replacement or repair of these tools that are used for subsistence harvesting is costly.

Additionally, subsistence hunters report that seismic activity displaces game, especially caribou, wolves and wolverine from the area being surveyed (USDOI-BLM SAP 2006a). Because of the harsh conditions during the winter, many caribou hunts are based from remote hunting cabins, many of which are located on BLM lands. If seismic activity occurs near a hunter's cabin locale, the resulting displacement causes the hunter to have to travel farther away. Disturbance of subsistence activities by seismic activities affects subsistence users in the following ways: loss of subsistence food; loss of time; loss of money; increased stress and anxiety; increased risk of equipment failure; and increased risk of loss of life or serious bodily injury. These affects may also put more responsibility on local municipalities to provide rescue response. Similarly, hunters who conduct day trips from their community have the potential to experience similar impacts.

Nuiqsut, located on the eastern boundary of the planning area, has the greatest potential to be impacted by seismic activities in Northeast NPR-A, which is that community's primary harvest area. Hunters from Barrow and Atqasuk may also harvest from the planning area during the winter, and residents of Anaktuvuk Pass may utilize the foothills area in southern Northeast NPR-A during the winter months. It is unlikely that residents from Wainwright would utilize the area during winter.

The use of airguns for boat-based seismic work could occur in Teshekpuk Lake during the summer under Alternative A. Airguns have been shown to affect mortality in eggs and juvenile fish, and result in flight response for adult fish (see **section 4.3.7.1**). These activities could affect the subsistence harvest of broad whitefish, arctic grayling, burbot and lake trout in river and stream systems connected to Teshekpuk Lake, including the Miguakiak and the Ikpikpuk

Rivers. There is potential for long-term impacts to subsistence fishing if large quantities of eggs and/or juvenile fish suffer mortality. Altogether, these effects could result in lower harvests for subsistence users. In addition, subsistence fishers who customarily utilize Teshekpuk Lake would likely avoid setting nets or fishing in the lake during the timeframe of this activity. Summer seismic activity in Teshekpuk Lake would primarily affect the communities of Barrow and Nuiqsut.

Exploratory Drilling

Exploratory drilling is carried out in order to test potential locations that have been identified by seismic exploration as likely to contain subsurface fluids or gas. The only way to determine whether the area contains oil, gas or water is to drill an exploratory well and conduct tests. Unless the exploratory drilling operation is conducted from one of the three existing gravel pads in the planning area (e.g., Lonely, Inigok, Umiat), exploratory drilling only occurs during the winter, once tundra travel has commenced. In order to drill an exploratory well, the operator must move a drill rig over either hardened snow trails or constructed ice roads to an ice pad. The route to the proposed drillsite is dependent upon the location of the rig, and the type of access used (i.e., snow trail or ice road) is dependent upon the type of rig and the type of support vehicles employed. If the rig can be broken down into smaller components and/or rolligon or tracked vehicles are the primary means of getting the rig to the proposed location, then companies usually rely on hardened snow trails for access. If the rig cannot be broken down and/or needs to be trucked to the location, then ice roads are the primary means of access. Usually, if more than one location is to be drilled, then an ice road is constructed between the two locations in order to avoid the time it takes to break down and reassemble the rig. If necessary, drill rigs and other equipment may need to be "staged" within the planning area prior to the winter operating season. This may require companies to make several barge trips back and forth from Prudhoe Bay and other current facilities to staging areas, such as the Lonely DEW Line Site, during the open water season.

Under Alternative A, it is estimated that 86 exploratory wells will be drilled in the planning area, with an additional 65 delineation wells drilled in subsequent years near wells that showed potential as oil producers. Wells that do not indicate the presence of hydrocarbons in developable quantities will be plugged and abandoned. Wells that show potential may be "suspended," and capped with what is known as a "Christmas tree" at the surface. It is anticipated that at most, five drill rigs will be operating in the planning area in any given winter season.

Winter exploratory drilling operations are always conducted from an ice pad, which also holds the crew quarters, an equipment area, a shop, and other necessary portable buildings for the operation. An ice airstrip is usually constructed near the drilling operation to facilitate crew changes and for resupply, especially if access was by snow trail. Ice airstrips are frequently constructed on lakes, which may be the only level ground in the area. In order to construct the ice pad, airstrip, and ice roads, as well as throughout the drilling operation, the company needs a large supply of water. This water is obtained from the numerous lakes and ponds present in the planning area, and companies are allowed by the State to withdraw a certain amount of water from each lake based on the volume and the presence or absence of certain species of fish. As a result of this, research needs to be conducted by the operator during the summer in order to identify the proposed route to the drillsite(s), to test potential lakes for water withdrawal, and to identify any cultural resources along the access route and in the area of drilling. Along with these summer studies, the company must also "stake" the proposed drilling locations, which involves inspection by BLM to ensure that location of the drillsite conforms to the

stipulations for that planning area. Most of the summer studies, route identification, and stakings are conducted via helicopter.

The summer activity associated with exploratory drilling would result in impacts to subsistence resources and users similar to those discussed above under non-oil and gas activities—namely, displacement of resources due to aircraft or watercraft use; impacts to hunters from disrupted hunts; and possible increases in the amount of time, effort, and fuel needed to harvest displaced animals. Impacts to harvesters during the summer would be greatest during those times that caribou are intensively harvested, namely the late summer/early fall months of August through October, when caribou are considered in their prime before the fall rut. The planning area is used intensively by the community of Nuiqsut, and used regularly by residents of Barrow and Atqasuk. Hunters from Wainwright and Anaktuvuk Pass occasionally travel into the planning area, usually when hunting with friends and family from one of the other communities.

Direct impacts to subsistence users and resources from the exploratory drilling operation would be similar to those discussed above under seismic exploration, including: displacement of resources from along access routes, especially ice roads during their construction; displacement of resources away from the drillsite; possible impacts to overwintering fish from water withdrawals, river crossings, and fuel spills near ice airstrips; and increased time, effort, and expense during hunting. Ice roads and/or packed snow trails are customarily used by local residents during the winter, both by snowmobile and truck/car. The presence of these types of access may concentrate hunting efforts along the route(s). In addition, increased traffic by locals increases the likelihood that resources such as caribou will be displaced from the route.

Caribou are year-round residents of the planning area, and the TLH is not habituated to oil and gas activities. Muskox are not frequently observed in the planning area, but would likely avoid activity areas, as would moose using riparian habitats. Other terrestrial mammals (e.g., grizzly and polar bears, wolves, and wolverines) would also avoid oil and gas activity areas, although some animals (e.g., denning grizzly and polar bears) would not be able to avoid these activity areas. In addition, if grizzly bears and polar bears were to associate oil and gas activity areas with food, then they might be attracted to these areas. Oil and gas activity areas would be likely to attract foxes, which associate these areas with denning habitat and food in the form of handouts and trash (Burgess 2000).

Overwintering fish could be affected by exploratory drilling activities, however, stipulations limit the placement of temporary infrastructure and fuel caches, and lessen the potential for impact to this resource. Likewise, waterfowl are not expected to be impacted by winter exploratory drilling, as they are not present in the planning area. Depending on the location of the ice pad, harvestable vegetation, such as berries or willow leaves, could be impacted during the summer immediately following the activity. However, this would be temporary and only cover a small amount of total area.

Alternative A would not be expected to affect marine mammals, unless the barging of equipment to staging areas was required during the open water season. If barging were to take place during the fall bowhead whale hunt, this activity could affect whalers from Nuiqsut and Barrow. Other, smaller-scale sea mammal harvests could also be affected. Seals may also use the Ikpikpuk and Colville rivers (Nigeluk Channel) seasonally in the summer and the nearshore environment in later winter and early spring. Aircraft traffic, vehicle traffic on nearshore ice roads, and activities near the rivers could affect spotted, ringed, and bearded seals by increasing their levels of stress and restricting their access to some habitats.

Development and Permanent Facilities

Once oil is found in commercial quantities, companies enter into the Development Phase of operation. This includes the construction of permanent facilities, including: roads, pipelines, gravel drilling/production pads, airstrips, central processing facilities, and possibly, staging areas for the storage of equipment and supplies during the construction period. The large amount of gravel needed during the construction phase would require companies to locate and utilize gravel pits, or barge gravel to the area. Under Alternative A, it is estimated that there will be a need for five central processing facilities (90 acres each) in the planning area. In conjunction with these facilities there are other support structures, such as gravel production pads, gravel runways in-field gravel roads, several types of pipelines, and other associated structures, that will also cause surface disturbances.

It is estimated that under Alternative A, there will be: 23 gravel production pads (10 acres each); 5 gravel runways (11 acres each); 230 miles of in-field gravel roads (7.75 acres/mile); 230 miles of three-phase produced fluids (oil, gas, water) gathering lines; 162 miles of sales oil pipelines; 5 pump stations (20 acres each); 2 staging bases (50 acres each); and 11 gravel pits (50 acres each). It is estimated that during the construction phase of these facilities that the total disturbance would be 4,679 acres. Construction of the permanent facilities will primarily take place during the winter, using ice roads and pads in the area of development to move and stage machinery, supplies, personnel and housing. It is estimated that construction for a typical development would take a minimum of 3-6 years. During this construction phase, it is estimated that there would be an average of approximately 115-160 one-way aircraft flights per month during the winter, and 70-90 one-way operational flights per month during the summer. Construction activities could result in an economic boon to local communities, and could directly affect harvesters if they were hired by the companies. This increase in income could offset the increased cost of fuel needed to harvest displaced resources, but might also lead to a corresponding decrease in the amount of time a harvester could be out on the land depending on the work schedule (see **sections 4.3.13.2 and 4.3.18.2** for further discussion on economic impacts).

After construction is completed, the production phase would begin. Because the development would be "roadless" (i.e., not connected to outside oil and gas infrastructure by gravel road, with the only gravel roads between the productions and the CPF) primary access to the area would be by aircraft. It is estimated that there would be an average of 8-32 flights per month during the winter, and 8 to 80 flights per month in summer.

Caribou are year-round residents of the planning area, and the TLH is not habituated to oil and gas activities. Prior to becoming habituated to development activities, the TLH caribou would likely be wary of and avoid the new infrastructure and associated activities (USDOI BLM 2003). During the construction phase, caribou would most likely avoid the area of development, due to the noise and disturbance caused by construction activities. The effects of disturbance from permanent oil and gas facilities on terrestrial mammals during the production phase would be of relatively long duration, but would be local in nature. This disturbance would consist of noise from the CPF, noise and visual impacts from traffic on the roads between the production pads and the CPF, and aircraft flights to the area. These effects would continue until species were able to habituate to the new environment, which could take several years (e.g., for infrastructure), or could never occur (e.g., for human and vehicle activities; Murphy and Lawhead 2000).

Winter oil and gas activities would not affect waterfowl; however, waterfowl could be affected by changes to nesting and molting habitat due to oil and gas activities in the summer. For example, gravel extraction could create new habitat (e.g., dredge ponds) favorable for the survival of waterfowl, as these deep ponds would be inaccessible to predators. However, waterfowl could be negatively affected by vehicle strikes (e.g. aircraft and trucks), and accidental collisions with structures and powerlines (USDOI BLM 2003). Increases in fox and other predator populations associated with human activities could also result in an increased risk for predation of molting geese. Overall, disturbance to waterfowl caused by oil and gas activities would be localized and infrequent.

Fish and fish habitats could be affected by water withdrawals, gravel mines, changes to hydrologic regimes due to infrastructure (e.g., pads, roads, causeways, docks, bridges and culverts), increases in turbidity and salinity, oil and hazardous materials spills, and access to new habitats. These activities have the potential to reduce fish populations, divert fish from their normal locations, kill large numbers of fish, or contaminate fish populations and habitat. Depending on the event or activity, effects could be widespread, last from one season to several years, and result in population level effects on fish.

Based on data from Pedersen et al. (2000) and Pedersen and Taalak (2001), as a consequence of oil development, Nuiqsut harvesters avoid development, with approximately 78% of the 1993 and 1994 caribou harvests occurring greater than 16 miles from the development east of the Colville River. In addition, 51% of the 1999-2000 harvests occurred greater than 16 miles from the Alpine field and 27% occurred 6 to 15 miles from the Alpine field. The avoidance of development by harvesters has two aspects: 1) the concern that discharging a firearm near the various facilities and infrastructure will result in liability for damage, death to a worker, or serious environmental consequences (e.g., an oil spill resulting from a punctured pipeline); and 2) the belief that animals that have habituated to oil and gas infrastructure are contaminated and not safe for human consumption. As a result, the total area of any development in the planning area could be effectively removed from the traditional harvest area of a given community.

The connection via pipeline of production pads to the CPFs and the CPFs to the existing pipeline system could result in travel and access issues for harvesters utilizing the planning area. For example, the speculative future pipeline corridors as depicted in Figure 4.2 surround the community of Nuiqsut, creating an obstacle between the community and their primary harvest area to the west, and to the Colville Delta to the north. Under Alternative A, pipeline height is stipulated as a minimum of five feet above the ground surface, a height that residents feel is inadequate for the passage of caribou and harvesters during the winter due to snow accumulation, and possibly during the summer depending upon the terrain.

Nuiqsut hunters would be the most affected by development in the planning area, while Barrow and Atqasuk may be affected, and Wainwright and Anaktuvuk Pass hunters would likely see fewer effects, as development would likely proceed west from the Nuiqsut vicinity.

Conclusion

Muskox and moose are rarely seen in the planning area, and muskox are not a preferred subsistence food. However, moose are harvested along the Colville River between Nuiqsut and Umiat, and subsistence hunting of this species could be affected by oil and gas activity in the Umiat vicinity. Subsistence users primarily harvest fox and bear when they become nuisances or dangers (SRBA 2003a,b). Wolf and wolverine hunting is a major activity for Nuiqsut, Barrow,

and Atqasuk in the planning area, and subsistence users have noted that these species have avoided areas where they normally could be found because of oil and gas activity. These species are important for cash and for traditional clothing.

Waterfowl harvests could be affected, as oil and gas activity could cause migratory birds to move outside of their normal migration routes and nesting and molting areas. Although new gravel ponds could increase population numbers by increasing the protected habitat available to birds, they could also put waterfowl out of reach of subsistence users. For subsistence users who prefer not to hunt near oil infrastructure, birds using habitats near facilities would effectively be inaccessible. Oil and gas activity under Alternative A could affect waterfowl subsistence harvest patterns if waterfowl avoid traditional harvest locations. Nuiqsut is the community most likely to be affected by any change in waterfowl numbers or availability within the planning area; however, hunters would continue to be able to harvest early arriving birds following the Colville River en route to coastal areas. Should impacts result in population-level decreases, then communities on the North Slope, the Seward Peninsula, and in the Yukon-Kuskokwim Delta Region could all be affected.

Seal in nearshore and riverine habitats could be affected by oil and gas activities. However, these animals should still be available to hunters from Nuiqsut. With few exceptions, Barrow, Atqasuk, Wainwright and Anaktuvuk Pass hunters do not travel to the planning area to harvest seals or other marine mammals (SRBA 2003a,b).

Fish and their habitats could be disturbed by oil and gas activities. In the past, Iñupiat subsistence users associated fish kills with seismic testing across water bodies and oil and fuel spills (Edwardson 1976). However, these effects have not been cited as recent occurrences since the early 1980s, and likely have been corrected with improved seismic testing and hazardous materials handling and transport methods. Fish provide approximately 30-40% of Nuiqsut's and 7-14% of Barrow's subsistence harvest by weight (see **section 3.4.2**), the two communities who primarily use the planning area for fishing. An interruption in subsistence fishing would cause severe hardship for Nuiqsut, and would present challenges for Barrow. Thus, Nuiqsut subsistence harvest patterns for fish are the most likely to be affected by disturbances from oil and gas activities under the Alternative A.

The resource to most likely be impacted by oil and gas activities in the planning area is also one of the most crucial to the residents of the North Slope—caribou. The area north of Teshekpuk Lake has been identified as core calving and insect-relief habitat for the TLH. Under Alternative A, this area would not be offered for oil and gas leasing, and seismic activity would only be permitted in the non-vital winter months. Depending on their location, permanent facilities, including roads and pipelines, could affect the movement of caribou from overwintering areas to the calving and insect-relief area. This change could affect harvesters by displacing caribou further from their customary harvesting locales, and result in stress and missed opportunities if harvesters were unable to apply traditional knowledge regarding caribou movement during the course of the hunt. No population-level effects to the TLH are anticipated under this alternative, however, it is expected that caribou would be displaced from areas of exploration and construction during the period of activity, and possibly from permanent facilities during the life of the producing oil field.

Overall, disturbances from oil and gas activities under Alternative A would have an effect on subsistence harvest patterns by causing subsistence resources to move away from areas of activity, and hunters to avoid areas of development in their entirety. In addition to having to travel greater distances to harvest resources that are displaced by exploratory activities,

resulting in great expenditures of time, effort, and cash, the disturbance caused to the snow surface by seismic exploration increases the likelihood that equipment would be damaged or subsistence users potentially injured in crossing the trails (ICAS 2004). It is not likely that the displacement of subsistence resources and hunters would be great enough to substantially reduce subsistence harvests.

Effects of Abandonment and Rehabilitation

During oil facility abandonment and rehabilitation activities, which include the removal of all equipment and facilities, and the plugging of all wells, subsistence resources and activities would be subject to impacts similar to those caused by construction. Following the abandonment and rehabilitation, subsistence resources would be subject to fewer impacts. If the gravel roads and pads were left in place and remained serviceable, they could be used by residents to provide access to subsistence resources, possibly reducing hunting effort and time.

Effects of Spills

Under Alternative A, it is assumed that 2.175 large spills (e.g., greater than or equal to 500 barrels of oil, but less than 120,000 barrels) consisting of an estimated total of 10,440 barrels of oil, could occur in the planning area. Small spills (e.g., less than 500 barrels) are currently the most frequently-occurring spill type on the North Slope, and primarily consist of the release of less than a barrel of aviation fuel, diesel fuel, engine lube oil, fuels oil, gasoline, grease, hydraulic oil, transformer oil and transmission oil. Under Alternative A it is estimated that a total of 516 small crude oil spills and 1,276 refined oil spills could occur in the planning area. A very-large spill, defined as a spill greater than or equal to 120,000 barrels of oil, is considered extremely unlikely to occur within the lifetime of this plan.

The effects of oil spills on subsistence species would depend upon the size of the oil spill and the environment in which the oil spill occurred. Spills contained on pads (small and some large) would likely have few impacts to subsistence species, as companies are required to report and quickly contain/clean-up these types of spills. In addition, oil spills (small and large) on the tundra, if they did not escape to a waterway and occurred on snow or frozen tundra, could affect small numbers of terrestrial mammals and waterfowl that were unable to avoid the spill area, but would be unlikely to have population-level effects. Oil spills on wet or non-frozen tundra would have some possibility of seeping into lakes and streams, and very large spills would most likely contaminate a waterway. Oil spills directly into a water body, particularly under conditions that made them difficult to contain, such as during breakup or when there is broken ice, could spread widely and be toxic to fish and waterfowl, leading to long-term, population level effects. In the nearshore environment, a large to very large spill, particularly when there is broken ice or storm conditions, could also affect marine mammals, such as seals, and beluga and bowhead whales.

The Iñupiat people consider contamination from oil spills in nearshore waters to be a catastrophic possibility that would threaten their very existence (Brower 1976, Itta 2001). A large or very large oil spill into nearshore or riverine environments could cause injury or death to bowhead whales, or cause them to move off of their normal course, thereby making them unavailable for subsistence harvest for Nuiqsut, Barrow, Wainwright, and possibly other communities. In this unlikely event, residents of both whaling and non-whaling communities would lose an important source of subsistence food as well as face issues of contamination, increased cost and effort to replace lost resources, social disruption due to resource damage and inability to participate in whaling, and financial hardship cause by the loss of a major source of

subsistence food. Subsistence users would likely also allow for a period of time for the resources, especially bowhead whales, to recover following exposure to oil. Such an event could also trigger a reduction in the International Whaling Commission subsistence bowhead whale quota, causing hardship to all subsistence whaling communities in Alaska, Arctic Canada, and Eastern Siberia.

A spill could interrupt subsistence seal hunting and fishing in riverine, lacustrine, or nearshore environments. The effects of a spill into lakes, rivers, or nearshore waters would extend beyond the margins of the spill itself, and concerns about contamination would last for many years. In Barrow, marine mammals, including seals and whales, supply from 53 to 74% of the total subsistence harvest by weight. Marine mammal harvests in Nuiqsut ranged from 8% in a poor year to 35% in a more successful bowhead whale harvest year. In Wainwright, the marine mammal harvest comprises 70% of the annual harvest during a successful bowhead year. Atqasuk residents harvest seals, and may harvest whales in cooperation with other communities, while Anaktuvuk Pass residents depend on trade for marine mammal products.

An oil spill (of any volume) into a river system or lake could affect subsistence fish harvests. Loss of some portion of the subsistence fish harvest from the planning area would negatively affect Barrow and Nuiqsut. Nuiqsut has depended upon fish for 30 to 45% of its total subsistence harvest by weight—the larger number when no bowhead whales were harvested. Barrow, Atqasuk, and Anaktuvuk Pass depend on subsistence fish harvests for varying proportions of their diet. A worst-case scenario would result from a spill into lakes, rivers, or nearshore waters, particularly in key areas such as spawning and feeding areas and overwintering habitat. In addition, broken ice conditions pose significant challenges to timely and effective cleanup. Any impact due to an oil spill would compound risks associated with current contamination levels.

Oil spills also have the potential to impact subsistence harvest patterns indirectly, in that subsistence users would decrease harvests of subsistence resources due to contamination concerns. For example, the people of Nuiqsut have a contamination issue with regard to burbot livers, which many residents believe should not be eaten because of high levels of toxic chemicals. According to interviewees, residents have been advised not to eat more than six burbot livers, the amount of one meal according to interviewees (SRBA 2003a,b). Despite scientific evidence to the contrary, numerous residents of Nuiqsut still believe that burbot livers are unsafe, and therefore, refrain from ingesting them. If the spill were to occur on the tundra, subsistence harvesters would not harvest caribou or other consumed resources from the general area.

Commercial Gas Development

Effects on subsistence resources and harvest patterns from natural gas development and production would occur in much the same way as effects would occur from oil development and production, though there would be no crude oil spills from gas production. Winter burial of the pipeline would potentially disrupt caribou and subsistence hunters, though once buried, a gas pipeline should not have additional impacts on subsistence. If a natural gas well blowout occurred, the subsistence harvest of any species in the vicinity could be affected and, if an explosion and fire occurred, subsistence resources in the immediate vicinity could be killed. Natural gas and condensates that did not burn in the blowout would be hazardous to any organism exposed in high concentrations. However, natural gas vapors and condensates would be dispersed very rapidly from the blowout site (1 km downwind for about 1 day) and would affect only those species in the immediate vicinity of the accident. While such an effect would

be relatively short term and localized and likely would not measurably affect the regional population of any species, it could cause disruption to subsistence harvests in the area of the blowout. In addition, subsistence hunters, who already tend to avoid oil field infrastructure, may be even more likely to avoid gas fields for fear of a well blowout.

4.3.12.3 Effectiveness of Stipulations

Many of the lease stipulations outlined in the 1998 Northeast IAP/EIS ROD relate to ensuring the continued health of subsistence resources and wildlife (USDOI BLM and MMS 1998). Oil and gas development is subject to continuous improvements in methods, and each new generation of technology improves safety and reliability. Many of the lease stipulations reflect knowledge gained from past mistakes and reflect a desire by BLM to safeguard wildlife and subsistence resources from harm. The 1998 Northeast IAP/EIS ROD calls for consultation with affected communities (Lease Stipulation 61), which would help include residents in the decision-making process for activities that could impact subsistence harvest activities in those communities.

Effectiveness of Stipulations on Subsistence Species

The lease stipulations in the 1998 Northeast IAP/EIS ROD would protect subsistence species by withdrawing critical habitat for TLH caribou calving and insect relief, as well as habitat for molting geese; establishing buffers around lakes and streams; mandating that exploration and construction activities minimize impacts on subsistence animals; and establishing conflict resolution processes. Buffers along rivers, where year-round surface occupancy would be prohibited, would protect fragile riparian habitat (Lease Stipulations 28, 39, and 41). The Teshekpuk Lake Surface Protection Area (Lease Stipulation 31) and the Pik Dunes LUEA (Lease Stipulation 45) would be unavailable for year-round occupation and would be seasonally closed to exploration and drilling. Protections for fish-bearing and deep-water lakes, streams, and nearshore habitats (Lease Stipulations 28, 30, 39, 40, 41, 46, 62, 70, and 78) would protect fish, waterfowl, and marine mammal species using those habitats. Maintaining the suitability of overwintering fish habitat, spawning areas, and feeding habitats are the key goals of lease stipulations addressing water and fish habitat management. Agency jurisdiction over these issues would be dependent on the water body (e.g., USACE on the Colville River Delta, and U.S. Coast Guard on navigable waters).

Protections for denning grizzly and polar bears and strategies for managing human-bear interaction have been designed to minimize effects to these animals (Lease Stipulations 2, 24, 72, 76, and 77). Lease stipulations intended to minimize effects on waterfowl populations include 21, 25, 31, 39, 46, 50 through 55, 57, 62, 71, 72, and 73. Caribou are addressed in Lease Stipulations 25, 29, 33 through 37, 49, 50 through 55, 57, 72, and 73. The main goals of the bear, waterfowl, and caribou lease stipulations are to protect these species while they are vulnerable (e.g., bears denning, caribou calving, and waterfowl nesting and molting). During these times, aircraft and ground activity would be regulated to minimize effects on these species. Raptors would be protected by aircraft harassment under Lease Stipulation 56.

Under lease stipulations outlined in the 1998 Northeast IAP/EIS ROD, development could proceed in areas that have already been leased. These activities would be bound by the lease stipulations of the ROD, with the caveat that procedures for the AO to grant exceptions to the lease stipulations exist (USDOI BLM and MMS 1998). Granting an exception would require the AO to find that implementation of the lease stipulation would be not technically feasible or economically prohibitive, or that an environmentally preferable alternative was available, and

that the alternative proposed by the lessee would fully satisfy the objectives of the lease stipulation.

Effectiveness of Stipulations on Subsistence Harvest Patterns

Lease stipulations to protect subsistence species, as listed above, should aid in keeping those species available to subsistence users by maintaining population numbers. The management goal of other lease stipulations would be to prevent oil and gas activities from causing subsistence resources to move outside of their traditional harvest areas (Lease Stipulations 23, 47, 51, 57, 59, 62, 72, 73, and 78). Additional lease stipulations would minimize conflicts with subsistence users by directing industry to avoid subsistence camps and cabins, maintaining subsistence access, and initiating consultation for conflict avoidance and resolution (Lease Stipulations 23, 26, 47, 59, 60, 61, 63 and 73). Lease Stipulation 71, prohibiting pesticide use, would reduce concerns about contamination for some species. Other lease stipulations could reduce concerns about the effects of development on subsistence resource availability and harvest success (Lease Stipulation 30), aircraft altitude and activity (Lease Stipulations 52 through 57, and 59), and surface activity (Lease Stipulations 24, 25, 34, 35, 36, 50, 51, and 73). Subsistence users in Nuiqsut believe that Lease Stipulation 37, which makes 5 feet the minimum pipeline height above ground, would be inadequate to allow caribou passage under most conditions (SRBA 2003a,b).

4.3.12.4 Conclusion

Most impacts associated with oil and gas exploration and development would be localized and would have minimal impacts to subsistence species. Because only 87% of the planning area would be available for leasing, impacts to subsistence resources should be less under Alternative A than the action alternatives. In addition, the lease stipulations discussed above would be protective of subsistence species and would help to resolve conflicts between the oil and gas industry and local residents. However, it is impossible to fully mitigate all impacts to subsistence use from oil and gas exploration and development, primarily the displacement of resources from areas of activity, and the disruption to hunters resulting from summer/fall aircraft use.

It was apparent from public scoping and hearing testimonies that local residents are concerned about the future of subsistence hunting on the North Slope, their ability to carry on with traditional customs and ways, and their ability to be able to pass along these traditions to their children. These issues are discussed in more detail in the next section.

4.3.13 Sociocultural Systems

The social and cultural effects of this plan would take place against a background of other continuing social effects caused by both oil development and the ongoing adaptation of Iñupiat residents to changing social, political, technological, and economic factors associated with the rapid introduction of hunter-gatherers to modern technical and industrial society (USDOI BLM and MMS 2003). The primary aspects of the sociocultural systems covered in this analysis include social organization, cultural values, and social health, as described in **section 3.4.3, *Sociocultural Systems*.**

Effects on social organization and cultural values from increased industrial activities, population, and employment, and from changes in subsistence harvest patterns associated with oil and gas development, could be brought about at both the community and regional level, as

Iñupiat cultural values and social organization transcend individual communities. Iñupiat are mobile between communities and often have lived in several communities over their lifetimes. Extensive kinship ties exist between communities and the value placed on subsistence activities and distribution is widespread throughout the North Slope.

As stated in Nuiqsut Paisanich (Brown 1979), "Today, as in the past, subsistence harvest of wild resources is the central occupation of traditionalist Iñupiat. Most of the people in Nuiqsut and other northern Alaska villages are traditionalists. Despite their acceptance of many elements of Euro-American culture, technology and economy, these people continue to participate in and depend on the subsistence way of life, either as hunters or as sponsors and sharers of the hunt. Subsistence provides such necessities as food and clothing, and it organizes the people's lives seasonally, socially, and ceremonially in the defining patterns of their culture." Subsistence activities are the vehicle through which culture and values are passed on to the next generation. It is also through the subsistence harvest that successful hunters are able engage in the sharing of meat, a tradition that is a significant part of the Iñupiat culture and that is key to the cohesiveness of families and communities.

Potential sociocultural effects associated with Alternative A include, but are not limited to, changes in social cohesion, changes in social interaction within and between communities, increases in suicides and violent crimes, high risk behavior and substance abuse, and decreases in cultural transmission between youths and elders (USDOI BLM and MMS 1998, 2003). These problems are also discussed in detail in **section 4.3.19, *Public Health*.** Iñupiat values in large part originate from and are sustained by subsistence activities and uses that include sharing, transfer of knowledge, satisfaction of eating traditional food, integrity of culturally important places, and autonomy. To the extent that outside influences come into conflict with those activities, they conflict with core Iñupiat values, and produce sociocultural consequences. In this sense, cultural values are a standard against which change can be compared. The impending change could allow greater opportunities for Iñupiat to realize their values and goals, or it could constrain and restrict the realization of these values and goals. In general, modernization in Inuit societies has been associated with the displacement of traditional subsistence-based sociocultural systems (Curtis et al. 2005; Shepard and Rode 1996).

An analysis of the social organization of a society involves examining how people are divided into social groups and networks. Activities such as the sharing of subsistence foods are profoundly important to the maintenance of Iñupiat family ties, kinship networks, and a sense of community well-being. In rural Alaskan Native communities, task groups associated with subsistence harvests are important in defining social roles and kinship. The individuals one cooperates with help define kin ties, and the distribution of specific tasks reflects and reinforces the roles of husbands, wives, grandparents, children, friends, and others (USDOI BLM and MMS 1998, 2003). Social groups generally are based on kinship and marriage systems, as well as on nonbiological alliance groups formed by characteristics such as age, sex, ethnicity, community, and trade. Kinship relations and nonbiological alliances serve to extend and ensure cooperation within the society. Social organization on the North Slope centers on group subsistence activities and on an extensive network that shares subsistence resources. An influx of a new population that caused growth in the community or change in the organization of social groups and networks could affect social organization. The interdependence of individuals within social and family kinship networks is known as "social capital." Measures of social capital tend to be high in subsistence-based cultures, and are associated with increased well-being and improved physical health (Wilkinson and Marmot 2003). Disruption of subsistence harvest task groups would damage the social bonds that hold the community together and

reduce social capital. In addition, disruption of the subsistence cycle could change the way these groups are organized.

An analysis of cultural values involves examining those values shared by most members of a social group. Effects on cultural values could result from a fundamental cultural change imposed or induced by external forces, such as when an incoming group causes acculturation of the residing group, or when a series of fundamental technological inventions change existing physical and social conditions. Such changes in cultural values can occur slowly and imperceptibly, or suddenly and dramatically (Chance 1990; Lantis 1959). For the system of sharing to operate properly, some households must be able to consistently produce a surplus of subsistence goods. For this reason, sharing, and the supply of subsistence foods in the sharing network, could be more sensitive to harvest disruptions than the actual harvest and consumption of these foods by active producers. Disruption of subsistence harvest patterns would conflict with cultural values, and could trigger an array of negative emotions such as fear, anger, and frustration, as well as a sense of loss and helplessness. Because of the importance of subsistence in sharing networks, threats to subsistence activities are a major cause for anxieties about oil development.

Alternative A would maintain the existing lease stipulations published in the 1998 Northeast IAP/EIS ROD. The area north of Teshekpuk Lake would be closed to year-round surface occupancy and leasing, and would continue to be protected, as would buffers around fish-bearing lakes and streams. Alternative A would be unlikely to cause further sociocultural impacts to the communities described in the affected environment; however, the existing and foreseeable impacts of this alternative should not be minimized or discounted depending on what projects are proposed and undertaken, where operations are to occur, how they are to be conducted, and when they occur.

4.3.13.1 Activities Not Associated With Oil and Gas Exploration and Development

Non-oil and gas activities include use of aircraft and watercraft, scientific research and data collection, recreation, overland moves, and solid and hazardous waste removal and remediation. Under Alternative A, these activities would be of short duration and would occur in limited areas. Research and data collection could result in the diversion or deflection of subsistence resources where helicopter or fixed-winged aircraft were used, which could result in local and temporary disruption to subsistence harvests of these resources. These localized and temporary effects would be unlikely to affect sociocultural patterns in North Slope communities. Archaeological research could increase interest in Iñupiat cultural history; however, some members of the community might oppose archaeological research for religious or cultural reasons. Recreational uses, primarily rafting and bird watching, would generally occur during the summer along rivers such as the Colville and Ikpikpuk, which could create localized and temporary effects (e.g. user conflicts and subsistence resource deflection), that would last only as long as these users were in the area. Overland moves are, in some cases, necessary for supplying communities with bulky goods and fuel, as well as for moving scientific and other camp equipment during the winter using low ground pressure vehicles, and are subject to the restrictions placed on such activities in the lease stipulations (USDOI BLM and MMS 1998). Effects from these overland moves would be temporary and would be unlikely to affect overall sociocultural patterns.

4.3.13.2 Oil and Gas Exploration and Development Activities

Alternative A would withhold approximately 600,000 acres from leasing and development, including a large portion of the Teshekpuk Lake Special Area. This would leave 87% of the planning area available for oil and gas leasing. Residents living on the North Slope, especially those living in the community of Nuiqsut, expressed their view in scoping and comment/ANILCA 810 meetings on the Amended IAP/EIS that the 1998 Northeast IAP/EIS ROD was a negotiated compromise between the Iñupiat people, the Federal government, and the oil industry.

Effects of Disturbances

Effects on Social Organization. As discussed in Chapter 3, the social organization of Iñupiat communities is strongly based on kinship, and the relationship that exists between extended families. It is kinship that defines the sharing network inherent to subsistence use, and comprises the foundation for community decision-making and well-being. Oil and gas activities that result in significant impacts to subsistence harvest have the potential to disrupt the customary sharing networks both within and between communities, especially if harvests were impacted in successive years. However, it is the inherent resilience of the sharing network to adapt to changing conditions and harvests that has allowed the Iñupiat to remain successful for thousands of years.

Effects on Cultural Values. Nuiqsut is the community in closest proximity to oil and gas development activity. Many Nuiqsut residents have stated during scoping testimony that they are being affected by oil and gas development and related activities enveloping the community from the east and excluding them from preferred subsistence harvest areas (Ahtuangaruak 2001). Oil and gas development in the central and southern portion of the planning area, as allowed under the 1998 Northeast IAP/EIS ROD, could further surround the community of Nuiqsut and increase the difficulty, expense, and risk of traveling to desired subsistence harvest areas. This development could also divert subsistence users for a distance of 5 to more than 25 miles from facilities. This would decrease the use of traditionally-used lands by reducing access to these lands and lowering the quality of the experience of and connections to the land for Iñupiat users. This disconnection from traditional uses threatens the subsistence way of life that is a major component of Iñupiat culture. Nuiqsut residents observe direct connections between the general well-being of their community and subsistence harvests (Ahtuangaruak 1997). To the extent that oil and gas activities conflict with ongoing subsistence activities, they conflict with Iñupiat cultural values.

Under Alternative A, subsistence harvest areas used by Nuiqsut, Atqasuk and Barrow for wolf and wolverine hunting, caribou harvests, and fishing would be available for year-round occupation and development, including large areas south of Teshekpuk Lake that are outside the setbacks protecting fish-bearing lakes and streams. In addition to being used for subsistence, this area contributes to the wilderness character and solitude desired by many North Slope residents. Oil and gas exploration and development could alter subsistence harvests in these areas, thus affecting cultural values such as transfer of knowledge between elders and youth related to those areas; the integrity of culturally important places; and the importance of hard work, cooperation, and sharing. Areas with traditional importance to families, such as camps and cabins used by many residents for caribou, fish and waterfowl hunting, would be protected by the closed area and stream and lake setbacks. This is consistent with the high value the Iñupiat place on these locations.

As discussed in the 1998 Northeast IAP/EIS, long-term change depends on the relative weakening of traditional stabilizing institutions through prolonged stress and disruptive effects that could be exacerbated by activities occurring under the planning area. These changes are already occurring to some degree on the North Slope as a result of onshore oil and gas development, more dependence on a wage economy, higher levels of education, improved technology, improved housing and community facilities, improved infrastructures, increased presence of non-Natives, increased travel outside of the North Slope, and the increasing presence of television and the Internet. Data from other circumpolar Inuit populations suggest that continued modernization is associated with a trend toward displacement of sociocultural systems, including: a trend toward less time being spent conducting subsistence harvest activities; less subsistence consumption among younger generations; a greater focus on a cash-based economy, as opposed to the egalitarian sharing network; an increased importance on the nuclear family, as opposed to the more-traditional extended family structure (Curtis et al. 2005; Nobmann et al. 2005; Condon et al. 1995). North Slope Borough institutions, such as the school district that promotes the teaching of Iñupiat language and culture, the Arctic Eskimo Whaling Commission that negotiates with industry to protect Iñupiat subsistence whaling interests, the NSB Department of Wildlife Management, and other regional and village Native corporations and organizations, have been working vigorously and quite successfully at preventing the weakening of traditional Iñupiat cultural institutions and practices. Increased social interactions between oil-industry workers and Nuiqsut residents could be long term, but there is not expected to be a tendency toward displacement of Iñupiat social institutions. However, population changes in ethnicity, such as the influx of a large non-native population, could disrupt or displace existing sociocultural systems and cultural institutions. Small-scale changes in population and employment are unlikely to disrupt sociocultural systems or displace existing institutions (USDOI BLM and MMS 1998, 2003).

Effects on Social Health. Public testimony indicates a relationship between oil and gas development and social stress or well-being (Ahtuangaruak 1997). Studies are currently being carried out or proposed to explore the relationship between oil and gas activity and social impacts, including: 1) a limited ethnographic and harvest pattern study of bowhead whaling at Cross Island (Galginaitis 2003), sponsored by MMS as part of a broader effort to monitor effects of British Petroleum's Northstar offshore oil development facility on selected environmental variables; and 2) a MMS sponsored study that will analyze NSB residents' observations and perceptions about effects from past, present, and future oil industry activities and other forces of modernity on their lives and subsistence whale hunting activities (EDAW In Prep). In addition, the NSB has submitted a grant request to the State of Alaska for a study of the cultural, social, and economic impacts to NPR-A subsistence communities resulting from current Arctic oil and gas exploration and production. Despite the lack of systematically collected data documenting the correlation between oil and gas development and social stress, years of testimony by residents during public meetings for BLM and MMS oil and gas lease sales relate the concerns, anxiety, and apprehension felt by locals regarding oil and gas activity, especially with regard to the lack of control they feel over what is happening on their traditional lands. Additionally, as described in more detail in **section 4.3.19**, existing public health data on indicators of social stress, for example, suicide rates, domestic violence prevalence, injury rates related to alcohol and substance abuse, as well as studies on the etiology of these problems in Arctic communities, suggest pathways through which industrial activity would be likely to impact social health.

Anaktuvuk Pass could be affected by oil and gas activity in the planning area under Alternative A, if TLH caribou were diverted or deflected from their normal migration routes by oil and gas activity. As discussed in **section 4.3.12, *Subsistence***, such effects have occurred in the recent

past. If subsistence foods were not available from Nuiqsut or other communities, it could be necessary for Anaktuvuk Pass hunters to travel outside of traditional harvest areas to harvest subsistence foods, which would increase the difficulty, expense, and risk of traveling to subsistence harvest areas. As a result, there would be an increase in social stress, as hunters would leave the community for longer periods to harvest resources, and potentially experience less successful hunts. Indirect effects could include increased competition for subsistence resources with other communities, a change in subsistence emphasis to other resources (e.g., sheep, moose, and fish), decreased self-sufficiency, and changes in relations with other Iñupiat communities.

Under Alternative A, staging for oil and gas activities in the planning area would occur primarily from facilities at the Prudhoe Bay/Deadhorse, Kuparuk, and other existing sites, which would reduce disruption to nearby communities. Increasing oil and gas activity could increase access to urban communities and cause more interaction with oil-industry workers, resulting in the introduction of new values and ideas as well as increased racial tensions and an increased availability of drugs and alcohol. Tensions would be created and could result in increased incidents of socially maladaptive behavior and family stress, potentially straining the ability of traditional Iñupiat institutions to maintain social stability and cultural continuity. See **section 4.3.19** for discussion on the impacts to Human Health.

Effects of Abandonment and Rehabilitation

Abandonment and rehabilitation activities would likely generate jobs for local residents for several years above the level that would exist during operations. However, after the production pads were shut down and termination activities were completed, jobs associated with them would cease. If local residents were to become substantially integrated into satellite operations and the community was to become substantially dependent on revenues associated with their operation, and if other oil fields were not active in the area to provide jobs and contribute economically to the local economy and government revenues, the community would face a time of economic depression, which is associated with increased social pathology in Inuit communities, as discussed in **section 4.3.19**. Other potential avenues for maintaining income at the standards established in the oil development era have not been identified. Subsistence resources would be subject to fewer impacts, potentially improving subsistence opportunities.

Effects of Oil Spills

Small spills that remained on land and did not spread to fresh water or marine environments would likely have a minor effect on overall sociocultural patterns. Large and very large spills, if contained on land, could disrupt subsistence harvests, as hunters would avoid contaminated resources, and not participate in traditional subsistence activities in contaminated areas. This decrease in participation could increase the cost and effort of harvesting uncontaminated resources, or lead residents to depend on store-bought foods.

A large or very large oil spill into a river, lake, or marine environment prior to breakup could contaminate a wide area with crude oil. Oil spills in these environments could affect fish and marine mammals, and many residents would decrease harvests of these contaminated resources. Effects on subsistence and sociocultural responses, similar to those described for the *Exxon Valdez* oil spill, could result from the unlikely, but possible, release of large volumes of crude oil in the planning area (Fall et al. 2001). If oil spill contamination concerns or clean-up activities were to result in the suspension of whaling, then Barrow, Nuiqsut, and Atqasuk would be directly affected for the duration of the suspension, as whaling is the basis for most

social organization and interaction in those communities. The Iñupiat believe that a large marine oil spill would injure or kill large numbers of whales, especially during the spring migration when whales and oil spills would concentrate in open leads (NRC 2003). In addition, the Iñupiat fear that the International Whaling Commission would reduce or curtail whaling quotas due to the increased threat to bowhead whales following a spill (Napageak 1990, NRC 2003). A reduction in International Whaling Commission bowhead whaling quotas on the North Slope would result in negative subsistence, economic, cultural, and social impacts throughout the region. Whaling is important to the Iñupiat for both subsistence and cultural purposes. Organization of whaling crews and preparations for the hunt reinforce social and cultural bonds, and processing of the whale often involves a large portion of the community. Therefore, disruptions to the bowhead whale hunts would affect social organization and add to social stress. Sharing of the whale is a valuable part of the Iñupiat culture, and a loss of this resource would affect cultural values and Iñupiat well-being. A large or very large oil spill into a riverine, lacustrine, or marine environment prior to breakup could indirectly affect Anaktuvuk Pass due to a decrease in bartered subsistence foods from other North Slope communities.

Other industrial activities associated with oil development that could have an effect on sociocultural systems would be those associated with cleanup if an oil spill did occur. In the event of a large spill contacting and extensively oiling habitats, the presence of hundreds of humans, boats, and aircraft would increase the displacement of subsistence species and alter or reduce access to subsistence species by subsistence hunters. Because oil spills would be small, chronic events, and would normally be contained on the drill pad, effects from the spills themselves and potential disruption from clean-up activities are not likely to cause great disturbance to sociocultural systems or the surrounding environment.

Commercial Gas Development

Effects on sociocultural systems under Alternative A and all other alternatives would be due to effects on subsistence harvest patterns, changes in employment and population, and effects on public health. In the event of natural gas development and production in the planning area, there could be an increase in employment and population in some North Slope communities and subsistence use patterns may be affected as described in **section 4.3.12**. The amount of employment and population change would probably differ among the alternatives in rough proportion to the amount of oil production and infrastructure development that would occur under each alternative; therefore, it is likely that least amount of employment and population impacts would occur under Alternative A.

4.3.13.3 Effectiveness of Stipulations

Under Alternative A, lease stipulations identified in the 1998 Northeast IAP/EIS ROD would remain in effect. These lease stipulations were the result of 18 months of intensive consultation among the communities near the planning area and the local, state, and Federal agencies with management interests in NPR-A lands and waters. The 79 lease stipulations provide protections for subsistence resources, cabins, camps, and river corridors, as well as the system of negotiating conflicts between permittees, leaseholders, and subsistence users. Lease stipulations relevant to sociocultural effects are also described in **section 4.3.12, *Subsistence***.

Under Alternative A, Lease Stipulation 39 would prohibit permanent oil and gas facilities, including roads, airstrips, and pipelines, within and adjacent to listed water bodies in order to protect fish and raptor habitat, cultural, and paleontological resources, and subsistence and other resource values (USDOI BLM and MMS 1998). Lease Stipulation 47 would prohibit

permanent oil and gas facilities within 1 mile of known long-term cabins or long-term campsites. Lease Stipulations 59 through 62 specifically address subsistence (e.g., management plans, consultation, and access to traditional use areas). Lease Stipulation 63 outlines an orientation program for all personnel involved in exploration or development and production activities. The purpose of this orientation would be to inform individuals working on the project of specific types of environmental, social, and cultural concerns that relate to the planning area and increase sensitivity and understanding of personnel to community values, customs, and lifestyles in areas in which personnel would be operating. Lease Stipulation 64 would require lessees to conduct an inventory of known traditional land use sites prior to any field activity, develop a plan to avoid these sites and mitigate any potential damage that could result from field activities, and indicate how local subsistence users would be provided access to the site. Lease Stipulation 73 would prohibit hunting and trapping by a lessee's employees, agents, and contractors when these persons are on "work status," and would prohibit use of lessee facilities, equipment, or transport for personnel access or aid in hunting and trapping. Lease Stipulation 74 would require lessees to conduct a cultural and paleontological resources survey prior to any ground-disturbing activity. If any potential cultural or paleontological resource were found during oil and gas activities, then the lessee or their designated representative would be required to notify the AO and suspend all operations in the immediate area of such discovery until written authorization to proceed was issued by the AO.

The implementation of the 1998 prescriptive lease stipulations has been underway for a relatively short period of time, limiting an empirical assessment of their effectiveness. However, the 1998 lease stipulations were developed through extensive consultation with local communities, and many local residents have testified that they believe the prescriptive stipulations in the 1998 ROD are effective at adequately mitigating impacts resulting from oil and gas activity and development in the NPR-A.

4.3.13.4 Conclusion

Oil and gas development in the planning area could surround the community of Nuiqsut, and increase the difficulty, expense, and risk of traveling to subsistence harvest areas. As a result, the continued use of and access to traditionally used lands could decrease, potentially threatening the subsistence way of life. Nuiqsut residents report in public testimony and scoping direct connections between the general well-being of their community and subsistence harvests (e.g., Ahtuangaruk 1997). To the extent that oil and gas activities conflict with ongoing subsistence activities, they conflict with Iñupiat cultural values and pose a risk to social health.

The lease stipulations listed in the 1998 Northeast IAP/EIS ROD were the result of several years of collaboration between the communities near the planning area and the local, state, and Federal agencies with management interests in NPR-A lands and waters. The prescriptive approach adopted in 1998 gained legitimacy and credibility through the extended consultation leading to the final decision. The lease stipulations provide protections for subsistence resources, cabins, camps, and river corridors, as well as the system of negotiating conflicts between permittees, leaseholders and subsistence users, through the Subsistence Advisory Panel. Although these lease stipulations would not eliminate conflicts between Iñupiat cultural values and oil and gas development activities, they would help to reduce these risks and allow Iñupiat cultural values to coexist with development.

4.3.14 Environmental Justice

Executive Order No. 12898 of February 1994 is "intended to promote nondiscrimination in Federal programs substantially affecting human health and the environment, and to provide minority communities and low-income communities access to public information on, and an opportunity for participation in, matters relating to human health and the environment." EO 12898 requires that Federal agencies collect and analyze information on the human health and subsistence effects, and to use this information to "determine whether their programs, policies, and activities have disproportionately high and adverse human health or environmental effects on minority populations and low-income populations."

U.S. Environmental Protection Agency guidelines for evaluating the potential environmental effects of projects require specific identification of minority populations when either: 1) a minority population exceeds 50% of the population of the affected area; or 2) a minority population represents a meaningfully greater increment of the affected population than of the population of some other appropriate geographic unit, as a whole. CEQ guidance on implementing EO 12898 suggest that to accomplish these goals, "Agencies should consider relevant public health data and industry data concerning the potential for multiple or cumulative exposure to human health or environmental hazards in the affected population." The CEQ further recommends that agencies specifically solicit input from local public health agencies and experts.

An extensive effort was made to provide all interested parties in the project vicinity with access to public information and opportunities to participate in the review process for this amendment (see **section 3.4.4, *Environmental Justice*, and Chapter 5, *Consultation and Coordination***). An informational letter was sent to individuals, organizations, Federal, state, and local agencies, and Alaska Native groups describing the proposed planning effort and requesting comments. Similar notices were published in newspapers in the area. Several meetings were held on the North Slope to solicit local community input early in the process. Every effort was made in the public consultation process to ensure that access to information was available to all interested parties in a non-discriminatory manner.

Subsistence activities in the planning area are important for providing dietary sustenance, and contribute to the health and well-being of North Slope residents. As a consequence, impacts to subsistence resources and access to those resources have a direct relationship to the analysis of whether the alternatives would have a disproportionate effect on minority and low-income populations.

4.3.14.1 Activities Not Associated With Oil and Gas Exploration and Development

As noted throughout this document, and in sections **4.3.12 *Subsistence*** and **4.3.19 *Public Health,*** in particular, the non-oil and gas activities likely to occur in the planning area would primarily be transitory in nature, of short duration, and highly localized. The effects of these activities on subsistence resources would be to temporarily divert or disturb subsistence species from their normal movement patterns or activities. Consequently, there could be an effect on the subsistence hunting activities of the local minority population as a result of non-oil and gas activities. These effects would be minor, temporary, short term, and generally highly localized. The effects on health, as described in **section 4.3.19.1**, would likely be sporadic and limited to impacts on individuals or families as opposed to impacting the health of the minority population.

4.3.14.2 Oil and Gas Exploration and Development Activities

Effects of Disturbance

Under Alternative A, oil and gas activities could have long-term effects on several terrestrial mammal species, although the effects would be localized in nature. Infrequent and localized effects on waterfowl harvested for subsistence could also occur. Onshore oil and gas activities would be expected to have little or no effect on marine mammals, but noise and disturbance associated with offshore barge and vessel traffic could impact bowhead whale migration patterns under Alternative A. There are concerns that, depending on the particular activity and, especially, the location of the activity, actions occurring under Alternative A could cause widespread effects on fish, perhaps to the level of affecting populations. All of these effects would be mostly experienced primarily by the subsistence dependent minority Iñupiat population.

Section 4.3.19.1 indicates that there could be substantial impacts to human health under Alternative A. These impacts would occur as a result of: potential restrictions in subsistence harvest and consumption; the influx of large numbers of outside workers; new access routes to the community; sociocultural and economic change; altered employment; and emissions. Diabetes, hypertension, and related metabolic disorders would be expected to increase as subsistence is curtailed or as sociocultural changes lead to alterations in dietary patterns. These health outcomes would be mitigated by measures which protect subsistence, but as displacement of fish, caribou, and potentially whales are still anticipated, mitigation would not be entirely effective. Cancer, lung disease, endocrine disruption, and neurodevelopmental delay are related to contaminants common to oil and gas development. However, the existing data, though incomplete, are reassuring as to present levels of contaminants. Social pathology could also result from the anticipated economic changes, increased access to drugs and alcohol, and from stress.

Effects of Abandonment and Rehabilitation

Activities associated with dismantling and removing of production pads and facilities could disproportionately impact Nuiqsut residents through disturbance, displacement, and mortality of subsistence resources, through subsistence users' avoidance of areas undergoing dismantlement and removal, and through potential impacts to water and air quality, and noise. Once abandonment and rehabilitation were completed, Nuiqsut residents would be disproportionately impacted by the reduction in local and Native corporation revenues and by fewer local jobs and business opportunities. Since economic depression is associated with increased social pathology, this could result in increases in domestic violence, injury, drug and alcohol problems, and suicide. Local residents could benefit from a reduction in impacts on subsistence resources, compared to during construction and operation.

Effects of Oil Spills

The effects of oil spills on subsistence species would greatly depend upon the size of the oil spill and the environment in which the oil spill occurred. Tundra oil spills could affect small numbers of terrestrial mammals and waterfowl unable to avoid the spill area, but would be unlikely to have population level effects. Oil spills directly into a water body, particularly in difficult to contain conditions, such as breakup or broken ice, could spread widely and have long-term, population level effects on fish and waterfowl. In the nearshore environment, a large

to very large spill, particularly during broken ice or storm conditions, could affect marine mammals including seals, and beluga and bowhead whales.

The Iñupiat people consider contamination from oil spills in nearshore waters to be a catastrophic possibility that would threaten their very existence, primarily because of the potential effects of spills on bowhead whales, which are a very important part of their culture in addition to being a favored food source (Brower 1976, Itta 2001). These effects include acute or chronic toxicity to whales or their prey. Thus, a major oil spill would result in effects that would impact Iñupiat subsistence users more than other human groups. Oil spills can also be associated with toxicological health effects in human populations, as outlined in **section 4.3.19**. Furthermore, if a large spill resulted in a substantial decrease in consumption of subsistence foods, food insecurity and hunger as well as diabetes and related metabolic disorders could increase.

Commercial Gas Development

Environmental Justice impacts of gas development for Alternative A would be largely attributable to impacts to subsistence, sociocultural changes, and public health impacts and are described, respectively, in **sections 4.3.12, 4.3.13, and 4.3.19**. While impacts from an oil spill would not be a factor, it is possible that well blowouts or the fear of blowouts would increase subsistence users' avoidance of infrastructure. The proportional impacts among the alternatives would mirror that attributed to oil development, and therefore the smallest impacts would be under Alternative A.

4.3.14.3 Effectiveness of Stipulations

Many of the lease stipulations outlined in the 1998 Northeast IAP/EIS ROD are designed to ensure the continued health of subsistence resources and wildlife (USDOI BLM and MMS 1998). Oil and gas development is subject to continuous improvements in methods, and each new generation of technology improves safety and reliability. Many of the lease stipulations reflect knowledge gained from past mistakes and reflect a desire by BLM to safeguard wildlife and subsistence resources from harm. Lease Stipulation 61 calls for consultation with affected communities, which would help include residents in the processes that could change subsistence harvest activities in those communities.

Lease stipulations to protect subsistence species should aid in keeping those species available to subsistence users by maintaining population numbers. The management goal of other lease stipulations would be to prevent oil and gas activities from harming or disturbing subsistence resources.

4.3.14.4 Conclusion

Several lease sales have already taken place in the planning area. Exploration programs, consisting of seismic testing and drilling using ice pads and roads, are ongoing. Residents of Barrow, Nuiqsut, and Atqasuk have noted some effects from these activities on subsistence (SRBA 2003a,b). One effect included the redistribution of caribou, wolves, and wolverines in response to seismic activity and cat trains operating in the NPR-A. While these effects would continue under Alternative A, most effects of disturbance would be localized, short term, and relatively minor. Since the amount of area available for leasing, and the number of seismic operations proposed is less, the effects to subsistence resources should be less under this alternative than the action alternatives. Effects from oil spills would depend greatly on the

size, location, and season of the spill. Small spills on gravel pads would have little or no environmental justice effects. A major spill into a watercourse, on the other hand, could have long-term serious effects on Iñupiat subsistence activities. While any major spill would have serious consequences, the worst, from an environmental justice standpoint, would be one that occurred in a key harvest area or near a community, particularly Nuiqsut.

The activities under Alternative A could also have substantial health effects, as outlined above and discussed in detail in **section 4.3.19**. Because the population within and near the planning area is primarily comprised of Iñupiat, any health effects that occur would disproportionately affect this minority population.

4.3.15 Coastal Zone Management

This section discusses the potential effects of management actions in the planning area on land use and consistency with Coastal Zone Management priorities under Alternative A. The following sections summarize the information previously presented in the 1998 Northeast IAP/EIS (USDOI BLM and MMS 1998), which has been amended with some additional data from studies conducted since 1998, particularly for the Northwest IAP/EIS (USDOI BLM and MMS 2003).

Federal lands within the NPR-A are excluded from the coastal zone; however, all uses and activities on Federal lands that occur within the coastal zone or that are expected to affect the coastal area and its resources must be consistent, to the maximum extent practicable, with enforceable standards of the Alaska Coastal Management Plan ACMP, including Alaska statewide standards in 11 AAC 112 and enforceable policies of the NSB Coastal Management Plan (CMP). Federal activities that affect coastal uses or resources require preparation of a Federal consistency determination that undergoes review by the State of Alaska. (11 AAC 112 is the standards section of the amended ACMP developed pursuant to 2003 ACMA revisions; the U.S. Department of Commerce, Office of Ocean and Coastal Resource Management (OCRM) approved the amended ACMP effective December 29, 2005).

The coastal area subject to a consistency determination includes a 25 mile strip of land along the coast and a one-mile area west of the Colville River. The coastal areas are indicated on the Coastal Zone Boundaries of Alaska maps posted on the ACMP web page at: http://alaskacoast.state.ak.us/District/swf/nwNSB.htm.

The NSB CMP addressed in this document reflects enforceable policies approved in 1988. Draft revisions to the NSB CMP are currently in review and must be approved by the State's Office of Project Management and Permitting, the DNR Commissioner, and the OCRM to comply with the amended ACMP. The NSB's Area Wide Comprehensive Plan was approved by the NSB Assembly in October 2005. The primary goal of the comprehensive plan is to protect the subsistence lifestyle of the NSB's largely Iñupiat population, while also encouraging and managing economic development.

Major land uses on the North Slope include traditional subsistence uses and hydrocarbon-development operations. Subsistence uses of coastal resources in the planning area have been, and will continue to be, of the highest priority to the NSB Iñupiat, given cultural and historic patterns of existence within the planning area. Stipulations for development prohibit severe harm to subsistence resources or activities or disturbance of cultural and historic sites. Stipulations address reasonable use of vehicles, vessels, and aircraft; engineering criteria for structures; drilling plans; oil spill control and clean-up plans; pipelines; causeways, residential

development associated with resource development; air and water quality; and solid-waste disposal.

4.3.15.1 Activities Not Associated With Oil and Gas Exploration and Development

Under Alternative A, non-oil and gas activities would be subject to all applicable lease stipulations listed in the 1998 Northeast IAP/EIS ROD (USDOI BLM and MMS 1998), as well as any other Federal, state, or NSB regulations that pertain to the activities in question. These activities would include aircraft use for point-to-point transport, wildlife, and other aerial surveys; ground activities such as seismic surveys, resource inventories for paleontological and cultural excavations, research and recreational camps, and overland moves; and guided hunting and river float activities on the Colville River from the headwaters to below Umiat. Hazardous and solid waste removal and remediation would continue to occur at abandoned drill sites. Oil spills could occur from fuel storage at construction sites and camps, but the size of such spills would likely be small (a few barrels), resulting in a small area of contamination. Clean-up activities are not likely to greatly disturb subsistence harvest activities or the surrounding environment. As non-oil and gas activities are normal occurrences under existing BLM management practices, it is expected that there would be little net change in the amount of disturbance to the primary uses of the planning area, which are related to subsistence resources and harvest patterns of nearby communities.

4.3.15.2 Oil and Gas Exploration and Development Activities

Under Alternative A, several ground-impacting management actions would be associated with oil and gas development. Most oil exploration activities, seismic surveys, and exploration drilling would occur in winter (early December to mid-April), although exploratory drilling would also be allowed only from current production pads or platforms sited within a lake body from May 20 through August 20 in the Teshekpuk Lake Caribou Habitat Area. Construction materials (and gravel for pads), personnel, and fuel would be transported over winter ice roads from existing infrastructure at Prudhoe Bay and Kuparuk. Large equipment would be barged to coastal staging areas in the summer, stockpiled, and moved inland the following winter.

As previously indicated, although all Federal lands, including those within the planning area, are categorically defined as being excluded from the coastal zone, all Federal activities and federally-permitted activities must be reviewed for consistency with the ACMP. Therefore, onshore activities within the planning area and some offshore activities identified under Alternative A should be assessed against the ACMP statewide standards and the enforceable policies of the, NSB CMP.

Although the entire planning area is technically outside the coastal zone, it is within the NSB. The NSB applies its Comprehensive Plan policies and CMP policies to all developments occurring on private, Federal, and state lands. Oil and gas development activities could include portions of road/pipeline corridors, including the offshore portions (such as inlets and bays) within the NSB boundary. Development activities occurring adjacent to the Colville and Ikpikpuk rivers that could affect coastal resources or uses, including activities described in exploration plans and development and production plans, could be subject to the statewide ACMP standards and NSB district enforceable policies of the ACMP. Policies of the ACMP are examined herein for potential conflicts with effects from oil and gas exploration or development activities. Potential effects are summarized as succinctly as possible. Additional information is

contained in the Coastal Zone Management section of the 1998 Northeast IAP/EIS (USDOI BLM and MMS 1998).

Effects of Exploration and Development on the Alaska Coastal Management Program

Section 307(c)(3)(B) of the Federal Coastal Zone Management Act requires applicants to certify that each activity described in an exploration or development and production plan that affects any land use or water use in the coastal zone complies with, and would be implemented consistent with, the state's coastal program. The state may concur with or object to an applicant's certification. The state reviews exploration and development and production plans to determine whether activities that could affect the coastal zone resources and uses are consistent with the ACMP.

The following paragraphs discuss ACMP uses and activities standards and resources and habitat standards related to Alternative A and to potential effects identified in other resource sections of the amendment. Policies of the current NSB CMP are assessed in conjunction with the most closely associated statewide standard. Generally, activities and uses that do not conform specifically to the standards must "avoid, minimize, or mitigate" adverse effects, which means avoiding "adverse impacts to the maximum extent practicable; where avoidance is not practicable, minimizing adverse impacts to the maximum extent practicable; or if neither avoidance nor minimization is practicable, conducting mitigation to the extent appropriate and practicable" (11 AAC 112.900).

This analysis is not a consistency determination pursuant to the CZMA of 1972, as amended, nor should it be used as a local planning document.

Coastal Development (11 AAC 112.200)

Water dependency is a prime criterion for development along the shoreline. The intent of this policy is to ensure that onshore developments and activities that could be placed inland would not displace activities that depend on shoreline locations, which include marine, lakeshore, and river waterfronts. Only activities around Kogru Inlet south of Atigaru Point would require a shoreline location, since almost the entire Beaufort Sea coast within the planning area is excluded from leasing under Alternative A. Protective measures would forbid most types of surface use for oil and gas activities, including permanent oil and gas surface occupancy, in sensitive issues areas along most of the coast and near deep-water lakes and major creeks and rivers (see Maps 3-6 and 3-7). Leasing would be allowed on lands subject to pending Kuukpik Corporation conveyances, but any lands selected before the sale would be deleted from the sale.

Lease stipulations in place under Alternative A would further reduce the potential for conflicts with this policy around lakes and rivers. Specifically, lease stipulations related to waste-prevention, handling, and disposal and spills (1 through 17); ice roads and water use (18 through 22); facility design and construction (29 through 48); abandonment (58); and protections for subsistence and traditional use sites (59 through 68); would reduce conflicts, making Alternative A consistent with this standard. Although large equipment could be barged outside the planning area to coastal staging areas in the summer and stockpiled until winter, no development activity would conflict with this policy.

Natural Hazard Areas (11 AAC 112.210)

This statewide standard permits coastal districts and state agencies to identify and designate areas in which natural hazards are known to exist that may present a threat to life or property. Development in these areas would be prohibited until siting, design, and construction measures for minimizing property damage and protecting against the loss of life were provided.

Flooding, earthquakes, active faults, tsunamis, landslides, volcanoes, storm surges, ice formations, snow avalanches, erosion, and beach processes in the planning area should be considered. Onshore development would be sited in areas of permafrost. Development in these areas would be required to maintain the natural permafrost insulation quality of existing soils and vegetation (NSB CMP 2.4.6[c] and NSB Municipal Code [NSBMC] 19.70.050.L.3). Lease stipulations (see Table 2-2 in Chapter 2) in place under Alternative A would reduce conflicts, making this alternative consistent with this standard.

Coastal Access (11 AAC 112.220)

Districts and state agencies shall ensure that projects maintain and, where appropriate, increase public access to, from, and along coastal water. Lease stipulations (see Table 2-2 in Chapter 2) in place under Alternative A would reduce conflicts, making the alternative consistent with this standard.

Energy Facilities (11 AAC 112.230)

The ACMP requires that decisions on the siting and approval of energy-related facilities be based, to the extent practicable, on 16 criteria within the energy facilities standard. Lease stipulations in place under Alternative A would reduce conflicts, making this alternative consistent with this standard.

Other criteria within this standard require that facilities be consolidated and sited in areas of least biological productivity, diversity, and vulnerability and where effluents and spills can be controlled or contained (11 AAC 112.230 (a) [3] and [14]). The NSB CMP also requires that transportation facilities and utilities must be consolidated to the maximum extent possible (NSB CMP 2.4.5.2[f] and NSBMC 19.70.050.K.6).

Construction associated with energy-related facilities under Alternative A would be required to comply with siting standards that apply to all types of development, which are discussed below under: 1) Habitats; 2) Air, Land, and Water Quality; and 3) Historic, Prehistoric, and Archeological Resources.

Utility Routes and Facilities (11 AAC 112.240) and Transportation Routes and Facilities (11 AAC 112.280)

These statewide standards require that routes for transportation and utilities be compatible with district programs and sited inland from shorelines and beaches. Utility routes and facilities along the coast must avoid, minimize, or mitigate alterations in drainage patterns, disruption in wildlife transit, and blockage of existing or traditional access.

The NSB CMP contains several additional policies related to transportation and utilities that may be relevant to this analysis. All but one of the policies are best-effort policies and subject to some flexibility if: 1) there is a substantial public need for the proposed use and activity; 2) all

feasible and prudent alternatives have been rigorously explored and objectively evaluated; and 3) all feasible and prudent steps have been taken to avoid the effects the policy was intended to prevent. Transportation development, including pipelines, which obstructs wildlife migration is subject to the three conditions listed above (NSB CMP 2.4.5.1[g] and NSBMC 19.70.050.J.3.f). **Section 4.3.9, *Mammals*,** indicates that interference with caribou movements would be temporary and brief under Alternative A; caribou migrations and overall distribution should not be affected. Lease stipulations related to the TLH caribou, including restrictions on overland moves and seismic work, oil and gas exploratory drilling, facility design and construction, ice roads and water use, ground transportation, and abandonment in place under Alternative A would further reduce conflicts, making Alternative A consistent with this standard.

Transportation and utility facilities would be consolidated to the maximum extent practicable. Therefore, there should be no conflict with either NSB CMP 2.4.5.1(i) (NSBMC 19.70.050.J.3.h), which discourages duplicative transportation corridors from resource-extraction sites, or NSB CMP 2.4.5.2(f) (NSBMC 19.70.050.K.6), which requires that transportation facilities and utilities be consolidated to the maximum extent practical. Lease stipulations (see Table 2-2 in Chapter 2) required under Alternative A would further reduce conflicts, making this alternative consistent with this standard.

The NSB CMP 2.4.6(b) (NSBMC 19.70.050.L.2), under the category of Minimization of Negative Impacts, requires that alterations to shorelines, watercourses, wetlands, and tidal marshes and substantial disturbance to important habitat associated with transportation and utilities be minimized, and that periods critical for fish migration be avoided. The discussion of habitats recognizes that alterations to wetland habitat and ponds and lakes would occur and birds could be disturbed during construction. These stipulations (see Table 2-2 in Chapter 2) identify constraints for the siting, design, construction, and maintenance of transportation and utility facilities. Lease stipulations in place under Alternative A would reduce conflicts, making Alternative A consistent with this standard.

Sand and Gravel Extraction (11 AAC 112.260)

Extraction of sand and gravel is a major concern on the North Slope. Gravel resources are needed for construction of pads, roadbeds, berms, causeways, and docks to protect the tundra. The ACMP statewide standards indicate sand and gravel may be extracted from coastal waters, intertidal areas, barrier islands, and spits if no practicable noncoastal alternative is available to meet the public need. Substantial alteration of shoreline dynamics is prohibited (NSB CMP 2.4.5.1[j] and NSBMC 19.70.050.J.3.i). Constraints may be placed on extraction activities to lessen environmental degradation of coastal lands and waters, if gravel is not obtained from inland sites, and to ensure floodplain integrity (NSB CMP 2.4.5.2[a] and [d] and NSBMC 19.70.050.K.1 and 4). The amount of extraction required to support oil and gas development under Alternative A, combined with the lease stipulations in place, would reduce conflicts, making this alternative consistent with this standard and the NSB policies.

Subsistence (11 AAC 112.270)

The statewide standard for subsistence indicates a project within a designated subsistence use area must avoid or minimize impacts to subsistence uses of coastal resources. Subsistence uses of coastal resources and maintenance of the subsistence way of life are primary concerns of the residents of the NSB. Under Alternative A, nearly the entire Beaufort Sea coast, except for the area around Kogru Inlet, within the planning area would be excluded from leasing, reducing potential disturbance to bowhead whales and other marine mammals. Teshekpuk Lake and the

areas north and east of the lake would not be available for leasing. However, access to subsistence resources, and subsistence hunting and resource use could be affected by reductions in subsistence resources and changes in their distribution patterns. These changes could occur as a result of disturbance from seismic surveys; aircraft and vessel traffic; drilling activities; and construction of pipelines, structures, support-bases, pump stations, and roads. Disturbances and oil spills associated with oil and gas activities would have short-term and localized impacts on the TLH caribou and other terrestrial mammals, fish, birds, and bowhead whales and other marine mammals. These impacts would not affect subsistence harvests for Barrow, Atqasuk, and Nuiqsut hunters. Subsistence-hunter concerns about access to resources and resource contamination would be minimal. Impacts would be further minimized by not leasing in important caribou, waterfowl, and fishing areas, and by protections afforded by lease stipulations identified in **sections 4.3.7, *Fish*, 4.3.8, *Birds*, and 4.3.9, *Mammals*** to protect marine and fish, waterfowl, and terrestrial mammals. Surface, air, and foot traffic near the oil fields would likely increase under Alternative A and displace some caribou, moose, muskox, grizzly bears, wolves, and wolverines, but would not substantially affect North Slope populations. This conclusion is based, on part, on the established policy that roads and pipelines be constructed to provide for unimpeded wildlife crossings. Based on the analysis of disturbance effects to caribou (described in **section 4.3.9**) and subsistence (described in Section 4.3.12), and the lease stipulations identified in Appendix D, potential conflict with the subsistence policies would be reduced, making Alternative A consistent with this standard.

Policy 2.4.3(d) (NSBMC 19.70.050.D) requires that development not preclude reasonable access to a subsistence resource. Onshore pipelines and construction activities could cause disruptions to subsistence caribou harvests from access and movement conflicts, but effects are expected to be short term. Where access is reduced or restricted, development can occur only if no feasible or prudent alternative is available, and is then subject to the conditions of best-effort policies. Conflict with these standards and policies also would be minimized under Alternative A by the exclusion of the Teshekpuk Lake Caribou Habitat LUEA from leasing.

Several important NSB CMP policies relate to effects on subsistence resources. The NSB CMP policy 2.4.3(a) (NSBMC 19.70.050.A) relates to extensive impacts to a subsistence resource that are likely and cannot be avoided or mitigated. In such an instance, development must not deplete subsistence resources below the subsistence needs of local residents of the NSB. Policy 2.4.5.1(a) (NSBMC 19.70.050.J.3.a) addresses development that would likely result in substantially decreased productivity of subsistence resources or their ecosystems. Temporary reductions in subsistence resources and changes in subsistence resource-distribution patterns could occur as a result of disturbance from seismic surveys, aircraft and vessel traffic, drilling activities, and construction activities (offshore dredging, pipeline construction, structure placement and onshore pipelines, and construction of support bases, pump stations, and roads).

Alternative A development scenario projects that there would be an onshore pipeline for oil delivery to the TAPS and that a pipeline spill could potentially contaminate the Colville River. A spill entering the Colville River could substantially affect the subsistence harvest by reducing fish populations, disrupting subsistence-fishing activity, and curtailing the subsistence hunt by tainting resources or making subsistence users perceive them as tainted. The effects of estimated oil spills of different sizes and their impacts on subsistence uses is discussed in **section 4.3.12**.

Conflict with these policies would be possible during the exploration, development, and production phases, but is more likely during development and production. Special lease stipulations (see Table 2-2 in Chapter 2) would be in place under Alternative A (**section 4.3.12,**

Subsistence) to protect subsistence resources, particularly lease stipulations that would establish procedures and advisory bodies to address subsistence resources, uses, and research for inventorying and monitoring; that would require that lessees not unreasonably restrict access in development areas to subsistence users; and that would prescribe conflict avoidance procedures under which lessees would consult with the NSB, affected communities, and the Subsistence Advisory Panel. Under Alternative A, representatives of Federal, state, and NSB agencies with biological expertise would participate on an interagency team that would coordinate research and monitoring projects related to the effectiveness of lease stipulations and surface resource impacts. Lease stipulations would also require lessees to develop an orientation program to increase sensitivity and understanding of local community values, customs, and lifestyles, and to provide guidance on avoiding conflicts with subsistence resources and activities. The lease stipulations would reduce subsistence conflicts, making Alternative A consistent with the statewide standard.

Habitats (11 AAC 112.300)

The statewide standard for habitats are specific to nine areas: offshore areas; estuaries; wetlands; tideflats; rocky islands and seacliffs; barrier islands and lagoons; exposed high-energy coasts; rivers, streams, and lakes (including associated floodplains and riparian management areas); and important upland habitat. The NSB CMP contains a district policy that reiterates the applicability of the statewide standard (NSB CMP 2.4.5.2[g] and NSBMC 19.70.050.K.7), plus several others that augment the overall policy or can be related to activities within a specific habitat. Under Alternative A, particularly sensitive habitat areas would be excluded from leasing. The special lease stipulations developed for Alternative A would provide protection for birds, terrestrial mammals, and fish and their habitats. Therefore, conflicts with the ACMP standards would be reduced and activities under Alternative A would be consistent with the statewide standard.

The ACMP statewide standard for habitats in the coastal zone requires that habitats be managed to avoid, minimize, or mitigate significant adverse impacts to habitat resources. This policy is supported by an NSB CMP policy requiring that development be located, designed, and maintained in a manner that prevents substantial impacts on fish and wildlife and their habitats, including water circulation and drainage patterns and coastal processes (NSB CMP 2.4.5.2[b] and NSBMC 19.70.050.K.2). In addition, vehicles, vessels, and aircraft that are likely to cause disturbance must avoid areas where species that are sensitive to noise or movement are concentrated, at times when such species are concentrated (NSB CMP 2.4.4[a] and NSBMC 19.70.050.I.1). Some disturbances associated with exploration and development would be mitigated by lease stipulations placed on permits. Special lease stipulations in place under Alternative A would reduce potential conflicts, and the activities would be consistent with the statewide standard.

Oil and gas development activities could affect several of the habitats identified in the statewide standard, including lagoons, wetlands, rivers, lakes, and streams. Therefore, onshore-development activities would need to be designed and constructed to "avoid, minimize, or mitigate significant adverse impacts" to natural water flow and drainage patterns, and competing uses such as commercial, recreational, or subsistence uses, to the extent that those uses are determined to be in competition with the proposed use. Water impoundments created by a pipeline/road corridor would have both positive and negative effects. In localized areas near the pipeline/road complex, impoundments would benefit some waterfowl by creating additional habitat, but would displace other nesting birds.

It is expected that caribou of the CAH and TLH would be disturbed and their movements delayed along the pipeline during periods of air overflights (i.e. pipeline inspections), but that disturbances would not affect migrations or overall distribution. It is expected that surface, air, and foot traffic near the oil fields would increase under Alternative A, displacing some caribou, moose, muskox, grizzly bears, wolves, and wolverines, though not enough to affect North Slope populations. The NSB CMP policy 2.4.6(e) (NSBMC 19.70.050.L.5) emphasizes that roads and pipelines must provide for unimpeded wildlife crossing and provides a set of guidelines and an intent statement specifically to implement the policy.

Rivers, lakes, and streams are managed to avoid, minimize, or mitigate significant adverse impacts to natural water flow, active floodplains, and natural vegetation within riparian management areas. Pipeline and road construction, including gravel extraction, could affect these waterways and would need to be conducted in a manner that would ensure the protection of riverine habitat and fish resources. Gravel extraction also is regulated under policies that are described in Section 11AAC 112.260. The special lease stipulations in place under Alternative A would reduce conflicts, making Alternative A consistent with the statewide standard.

Air, Land, and Water Quality (11 AAC 112.310)

The air, land, and water quality standard of the ACMP incorporates by reference all the statutes pertaining to, and regulations and procedures of, the ADEC. The NSB reiterates this standard in its district policies and emphasizes the need to comply with specific water and air quality regulations in several additional policies. Water quality can be affected by oil spills, deliberate discharges and emissions, and gravel operations. As a precaution against accidental spills, the NSB CMP requires the use of impermeable lining and diking for fuel-storage units with a capacity of greater than 660 gallons (NSB CMP 2.4.4[k] and NSBMC 19.70.050.I.11). In addition, development within 1,500 feet of a coast, lake, or river shoreline that has the potential to impact water quality (e.g., landfills, hazardous-materials storage areas, dumps, etc.) must comply with the conditions of the best-effort policies (NSB CMP 2.4.5.1[e] and NSBMC 19.70.050.J.3.d): 1) there must be a substantial public need, 2) the developer has rigorously explored and objectively evaluated all feasible and prudent alternatives and cannot comply with the policy, and 3) all feasible and prudent steps have been taken to avoid the effects the policy was intended to prevent. Under Alternative A, there could be some short-term conflict, pertaining to water quality and potential oil spills, between this policy and activities assumed under this alternative. However, the lease stipulations in place would reduce conflicts, and Alternative A would be consistent with the statewide standard.

Some discharges and emissions would occur during exploration and development, and the NSB CMP policy 2.4.4(c) (NSBMC 19.70.050.I.3) requires that these emissions comply with all state and Federal regulations, which is consistent with the statewide standard. Discharges of drilling muds, cuttings, and drilling fluids are regulated closely. Formation water produced from the wells along with the oil is regulated by the USEPA Underground Injection Control program. The Alaska Oil and Gas Conservation Commission has primacy for this program for Class II wells in the State of Alaska. Produced waters and drilling wastes fall within the Class II category. Some wastes are disposed of through the annulus of producing wells. This activity is exempt from the Underground Injection Control program; however, the Alaska Oil and Gas Conservation Commission also regulates this practice for the State of Alaska. Surface disposal of drilling wastes would require a solid waste permit from ADEC.

Because discharges are carefully regulated, no conflict is anticipated with the statewide standard or NSB CMP policy 2.4.4(d) (NSBMC 19.70.050.I.4), which requires that industrial

and commercial development be served by solid waste disposal facilities that meet state and Federal regulations. Any onshore development under Alternative A would be required to meet the statewide standard and the district policy related to solid-waste disposal. Assuming the regulations were implemented properly, including Lease Stipulation 13 related to waste handling and hazardous-material disposal and cleanup, there would be no inherent conflict between the proposed activities and the ACMP water-quality provisions.

Air quality also must conform to Federal and state standards (11 AAC 112.310, NSB CMP 2.4.3[i] and 2.4.4[c], and NSBMC 19.70.050.H and I.3). The analysis of air-quality effects under Alternative A in **section 4.3.1, *Air Quality*** indicates that conformance is anticipated, and no conflict between air quality and coastal policies should occur.

Historic, Prehistoric, and Archeological Resources (11 AAC 112.320)

The ACMP statewide standard requires that coastal districts and appropriate state agencies identify areas of the coast that are important to the study, understanding, or illustration of national, state, or local history or prehistory, including natural processes.

The NSB developed additional policies to ensure protection of its heritage. The NSB CMP 2.4.3(e) (NSBMC 19.70.050.E) requires that development that is likely to disturb cultural or historic sites listed on the National Register of Historic Places; sites eligible for inclusion in the National Register; or sites identified as important to the study, understanding, or illustration of national, state, or local history or prehistory shall 1) be required to avoid the sites, or 2) be required to consult with appropriate local, state, and Federal agencies and survey and excavate the site prior to disturbance. The NSB CMP 2.4.3(g) (NSBMC 19.70.050.G) also requires that development not disturb newly discovered historic or cultural sites prior to archeological investigation. Although the NPR-A is technically excluded from the coastal area, given the number of existing sites, it is likely that new cultural and paleontological sites would be discovered under Alternative A. However, conflicts with these policies should not occur since lease stipulations in place under Alternative A would require an inventory of traditional use sites prior to conducting any activities, which would reduce conflicts, making Alternative A consistent with the statewide standard.

Traditional activities at cultural or historic sites also are protected under the NSB CMP 2.4.3(f) (NSBMC 19.70.050.F) and 2.4.5.2(h) (NSBMC 19.70.050.K.8). As noted in the discussion of policies related to subsistence, the latter is a best-effort policy that requires protection for transportation to subsistence use areas as well as cultural use sites. There is no inherent reason to assume conflict with these policies.

Effects of Abandonment and Rehabilitation

Land ownership would not be affected by abandonment and rehabilitation. Upon completion of abandonment and rehabilitation, land uses and management could return to as near the original condition as practicable.

4.3.15.3 Effectiveness of Stipulations

Lease stipulations (see Table 2-2 in Chapter 2) referred to under each of the ACMP standards discussed above, and itemized in greater detail in **section 4.3.12, *Subsistence***, should be sufficient for Alternative A to achieve compliance with ACMP and NSB CMP policies and standards. While it is expected that there could be land use and ACMP standards conflicts over

the life of Alternative A development scenario, any such conflicts should be short term and subject to resolution. Conflicts, should they occur, would most likely result from oil and gas development activities interrupting subsistence activities, but the scale of development and enforcement of applicable lease stipulations would minimize the conflicts and quickly return the development to compliance with policies and standards.

4.3.15.4 Conclusion

Under Alternative A, conflicts could occur with specific ACMP statewide standards and NSB CMP enforceable policies related to potential user conflicts between development activities and access to subsistence resources. Conflicts with the NSB CMP policy related to effects on subsistence resources resulting from periodic disturbance and oil spills would be possible, but no resource would become unavailable, undesirable for use, or experience overall population reductions. These effects would occur in the unlikely event of spilled oil contacting subsistence resources and habitats, and during oil-spill cleanup. The lease stipulations in place under Alternative A, however, would reduce conflicts, making Alternative A consistent with ACMP standards.

It is expected that disturbance and oil spills associated with oil and gas activities would cause short-term and localized impacts to the TLH caribou and other terrestrial mammals, fish, birds, and bowhead whales and other marine mammals, but that subsistence-hunter concerns about access to resources and resource contamination would be minimal under Alternative A. Impacts would be minimized by not leasing in important caribou, waterfowl, and fishing areas and by implementing lease stipulations. Under the guiding assumptions of Alternative A, and with the lease stipulations in place, this alternative should be consistent with coastal management policies and standards of the ACMP and NSB CMP. Combined oversight by the BLM, the ADNR, and the NSB, under the guidance of their respective standards, would be sufficient to deal with any potential conflict that could arise between Alternative A and the policies addressed in this section.

4.3.16 Recreational Resources

4.3.16.1 Activities Not Associated With Oil and Gas Exploration and Development

Under Alternative A, some impacts to recreation resources would result from on-the-ground management activities such as archeological collection efforts, field camps, survey work, and overland moves. Over a period of 6-12 weeks, between June and September, possibly three to four camps, survey, or collection efforts are anticipated at any one time in the planning area. In winter, several overland moves may occur during a single season. Aircraft and watercraft activity, and ongoing solid and hazardous waste removal, would also be observable in the planning area.

Temporary structures (e.g., sleds, tents), vehicles (e.g., Rolligons, tractors), noise from generators, aircraft, human presence, and associated activity all would have some minimal short-term impact on the experience of solitude, naturalness, or primitive/unconfined recreation. These short-term impacts would be confined primarily to the activity site viewshed or noiseshed (approximately ½ mile in any direction or 500 acres) and are expected to affect no more than a total of approximately 2,000 acres at a time (500 acres each for four camps). Because all of these identified non-oil and gas activities would be transitory and short term, the likelihood of recreationists encountering them in any given location in the 4.6 million acre

planning area is probably small. If such activities were encountered, the recreation experience and opportunity for solitude on the North Slope would be diminished somewhat. Depending on the activity, there may be some increased likelihood of an encounter with recreationists because of the propensity to concentrate on major rivers and coastal areas.

A longer-lasting impact would be trails resulting from overland moves. These trails are created by vehicles compacting snow and dead vegetative matter that in turn results in the greater availability of moisture and nutrients for underlying vegetation the following growing season. These trails do not necessarily develop over the entire route of an overland move, but when they do they can be very detectable from the air for 2 to 5 years. They usually are difficult to recognize from the ground. Another impact along these trails that has occurred in the past is vegetation actually being damaged or broken or the tops of tussocks being scraped off. Current operating procedures make this an infrequent problem, but one that can occur in conjunction with these trails. Because overland moves would be relatively constant from year to year and generally follow the same route(s), several hundred to several thousand miles of intermittent trail in some phase of recovery (attributable to overland moves) could be visible from the air during any one summer season. Though still relatively short term in nature, the linear nature of these trails would emphasize the presence of man, which would reduce the sense of naturalness and unconfined primitiveness to a small degree.

Although there are no formal designations of wilderness or wild and scenic rivers in the planning area, and none are anticipated at this time, none of the identified non-oil and gas activities would diminish requisite wilderness and wild and scenic river characteristics sufficiently, to preclude such designations in the future.

4.3.16.2 Oil and Gas Exploration and Development Activities

Effects of Exploration

Under Alternative A, seismic-survey work could continue throughout the area with five operations each year. This work would occur in winter using all-terrain low-ground-pressure vehicles supported by light aircraft. Seismic crews are housed in mobile camps consisting of a train of trailer sleds pulled by tractors. These moving camps, associated noise (e.g., vehicles, aircraft), and activities would result in a short-term impact on the primitive setting of the planning area and a loss of solitude and naturalness. These impacts would be confined primarily to the activity site viewshed or noiseshed, or approximately ½ mile in any direction.

A longer lasting impact would be trails resulting from seismic survey operations. Unlike overland moves, seismic operations do not follow the same routes every year and the number of miles of survey line run can vary greatly from year to year. In some years, no surveys would occur. As with trails created by overland moves, these trails do not necessarily develop over the entire survey route and are visible for about 2 to 5 years. Because of the many variables involved, it is difficult to make a reliable estimate as to the number of miles of trail that would be visible during any one summer season as a result of seismic operations. However, oil and gas scenarios state that approximately 250 miles (6,060 acres) of line would be surveyed using 2-D seismic methods, while approximately 10,560 miles (98,880 acres) of line could be surveyed annually using 3-D seismic methods, potentially resulting in several thousand miles of trails. Mobile camp trails could add another 840 miles (3,056 acres) of trails. Although some of the camp train route could be outside of the planning area and could overlap survey line miles. The number of miles of trail visible would decline as this phase of exploration slows. Though relatively short term in nature, the linear nature of these trails would emphasize the presence

of man, which would reduce the sense of naturalness and unconfined primitiveness to a small degree.

Approximately 151 exploration and delineation wells are anticipated under Alternative A. However, due to the limited number of drilling rigs available, no more than five wells would be anticipated to be drilled at any one time. Drilling would occur over several winter seasons using ice pads, roads, and airstrips. Temporary on-site location of structures (e.g., drilling rigs); noise from generators, vehicles, aircraft, etc.; human presence; and associated activity all would have short-term impacts on solitude, naturalness, and primitive/unconfined recreation experiences during the winter season. These impacts would be expected to be greatest within a 2-mile radius of the drilling site, which is an area of approximately 8,000 acres per well site. Accordingly, under this alternative, there would be a temporary loss of solitude, naturalness, or primitive/unconfined recreation over an area of approximately 40,000 acres in any given winter. This would be equivalent to about 0.01% of the planning area and the potential effect on recreation opportunities and experience would be further minimized by the fact that very little winter recreation takes place in the area.

In addition to the short-term impacts that result from ongoing exploratory drilling operations, an accumulating summer-season visual concern exists as a result of the greening of vegetation under vacated ice pads, airstrips, and roads. This direct impact to the area's naturalness would be a result of the same conditions that create "green trails," the greater availability of moisture and nutrients as ice or compacted snow melts. This greening of the vegetation does not necessarily develop wherever ice pads are constructed or snow is compacted, but when it does, it can be very detectable from the air for 2 to 5 years, somewhat less noticeable from the ground. Another impact at these sites would be vegetation actually being damaged or broken especially along the perimeter of a pad or edge of a road. Exploratory drilling operations and ancilliary facilities i.e. 151 ice pads (6 acres each), 20 airstrips (11 acres each) and 5,162 miles of ice roads(3 acres/mile) would result in as many as 16,768 acres that would be in a various state of recovery from these impacts.

Exploration wells that do not indicate the presence of hydrocarbons in developable quantities will be plugged and abandoned leaving nothing more than possibly a mound of dirt expected to be no larger than a square foot on the lands surface. Wells that show potential may be "suspended," and capped with what is known as a "Christmas tree" at the surface, especially if the well might be used again for possible oil production. These are essentially a permanent impacts (less than 6 feet high), but almost unnoticeable from several hundred feet away.

Effects of Development

Up to 23 production pads and 162 miles of pipeline that extend beyond the production area are anticipated under Alternative A. While the intensity of impacts would be greatest during actual construction and development of these facilities, remaining structures, human presence, and associated activity and noise all would have impacts on the experience of solitude, naturalness, and primitive/unconfined recreation opportunity during the life of the field. Because production could occur for 10-50 years beyond the development phase, impacts would be long term. These long-term impacts are expected to be greatest within two miles of a pad site (or an area of about 8,000 acres). Pipelines would be elevated at least five feet and would also impact recreation values.

There would be little if any associated on-the-ground activity, except during construction and repair. Long-term impacts to recreation values from pipelines are expected to be minimal

beyond about ½ mile. This equates to about 640 acres per mile of pipeline. Under this alternative, there would be a long-term loss of solitude, naturalness, or primitive/unconfined recreation opportunity over an area of up to 287,680 acres (i.e., [8,000 acres/pad x 23 pads] + [640 acres/mile x 162 miles of pipeline]). In addition, it is estimated that long-term surface (i.e. two miles from footprint of staging and CPFs) disturbance and consequently impacts to primitive recreation from two staging areas (50 acres each) and 5 CPFs (90 acres each) including pads, roads, airstrips, gravel pits, and infield gathering pipelines and associated infield gravel roads (280 miles) would impact 246,300 acres (i.e. [9,300 acres/staging area x 2 staging areas] + [9,700 acres/CPF x 5 CPFs] + [640 acres/mile of road x 280 miles]). These impacts combined (533,980 acres), would be equivalent to about 11.6% of the planning area. Short-term, routine/daily inspection flights also would impact solitude and naturalness along the length of all pipelines as long as they are in use. The potential effect on recreation opportunities and experience would be greatest for development activities, because it would entail year-round activity and would thus continue during the summer when most recreational activity in the planning area occurs. Therefore, the effects to recreation use would not be considered a great impact, because they would impact such a small portion of the planning area (11.6%) and because there is such a small amount of recreation use in the area. The actual effects would depend greatly on where development fields were located relative to major watercourses and the Beaufort Sea coast.

Effects of Abandonment and Rehabilitation

While abandonment and rehabilitation activities occurred, a small number of recreational users in the area of rehabilitation could have their wilderness experience diminished by noise, marred views, and disturbance to animals which they have come to observe (bird-watchers) or harvest (hunters). However, over the long term, these efforts would minimize and impacts to recreation use would likewise be minimized.

Effects of Spills

Most small spills would be confined to a pad. Small spills not confined to a pad usually are confined to the area immediately around the pad or pipeline and usually impact less than five acres. Therefore, impacts on solitude, naturalness, or primitive/unconfined recreation opportunities resulting from small spills likely would be confined to the same area as described above under Effects of Development.

A large spill that reaches a river, especially the Colville River, and moves rapidly downstream could have disastrous short-term (and possibly long-term) impacts on recreation values.

Effects to Wilderness and Wild and Scenic River Values

None of the identified non-oil and gas activities would diminish requisite characteristics sufficiently to preclude wilderness or wild and scenic river designations in the future.

Potential wilderness values of naturalness and outstanding opportunities for solitude and primitive, unconfined recreation experiences would be affected by long-term development of petroleum resources on as much as 13% of the planning area under Alternative A. Despite the lost values, over 4 million acres (87%) of the planning area would likely retain substantial wilderness values.

The "outstandingly remarkable values" that support Wild and Scenic River eligibility for the Colville River include recreation, wildlife viewing, geology and archeology upstream from Umiat, and paleontology and wildlife from Umiat to Nuiqsut. Only a small portion of the Colville River would experience effects to these values from activities associated with the Alternative A, primarily an expected pipeline crossing of the river in an as yet undetermined location. Specified buffer areas would provide substantial protection for the Colville and other rivers, except in the area very near an expected pipeline crossing. Although pipeline crossings are discouraged in designated Wild and Scenic River areas, they are permissible, when unavoidable, if measures to minimize effects on the river's outstandingly remarkable values are utilized.

Wild and Scenic River designation is not planned or proposed for the Colville River, as noted in **section 3.4.6.3**, but the applicable lease stipulations would preserve most, if not all, of the character and values that could qualify the river for designation in the future, if local and state political sentiments should ever determine designation to be favorable. A potential pipeline would not disrupt the requisite "free flowing" nature of the river and, to the degree possible, it would be sited to avoid the areas specific to the "outstandingly remarkable values" noted above. Selection of a river crossing location for the pipeline would require a permit from BLM, which would afford an opportunity for more detailed review of effects on the Wild and Scenic River eligibility of the Colville River.

Commercial Gas Development

Because a gas pipeline would likely be buried and because little recreation occurs in the planning area in the winter when construction would primarily occur, there would be very little impact to recreation from gas development. The exception might be if gas development prompted some development that would not occur if only oil could be developed. In those cases, impacts would be similar to those associated with oil development. Because less land would be available for such development under Alternative A than under the other alternatives, it is least likely to impact recreation.

4.3.16.3 Effectiveness of Stipulations

Although the lease stipulations in the 1998 Northeast IAP/EIS ROD do not specifically address recreation activities and there is no current intention to consider designation of wilderness or wild and scenic rivers in the planning area, many of the standards required for development of Alternative A would serve to protect recreation values in the area. For example, areas excluded from leasing and several lease stipulations address protection of subsistence values and wildlife in the planning area. Also, surface activity and facility development restrictions serve to minimize potentially damaging activity in and near creeks, rivers and lakes. Since wildlife viewing, big game hunting, and boating are major factors attracting recreationists to the planning area, these lease stipulations associated with Alternative A also serve to protect and preserve recreation values.

4.3.16.4 Conclusion

There would be approximately 2,000 acres in temporary impacts to recreation values from activities other than oil and gas exploration and development. Short-term (temporary) disturbance from ongoing oil and gas exploration activities would impact approximately 107,996 acres. The "greening" of vegetation resulting from ice pads, roads, airstrips, and compacted snow would impact an additional 16,768 acres. Most of the combined 124,764 acres could be in a

various state of recovery from the "greening" effect. Seismic operations would result in temporary impacts to recreation use over many hundreds of miles of trails and noise and other disturbance produced by seismic operations. Short-term impacts such as trails and pads, disturbance from noise, aircraft and other on-going activities would not accumulate.

Oil and gas development would result in the long-term loss of solitude, naturalness, or primitive/unconfined recreation opportunities over an area of approximately 533,980 acres (or 11.6% of the planning area) for the life of production fields and pipelines.

4.3.17 Visual Resources

4.3.17.1 Activities Not Associated with Oil and Gas Exploration and Development

Under Alternative A, impacts to visual resources would result from on-the-ground management activities, such as archaeological collection efforts, field camps, survey work, overland movements, and hazardous and solid material removal and remediation activities.

Temporary structures (e.g., sleds, tents), vehicles (e.g., Rolligons, tractors), aircraft, human presence, and associated activities would have some minimal short-term impacts on visual resources or scenic quality, by creating a contrast to the line, color, and texture of a primarily horizontal natural landscape. The colors of structures and equipment would contrast with the white color of the snow-covered landscape and the various hues of greens and browns, and the smooth texture of the facilities would contrast the varied textures of the windswept terrain and the irregular texture of vegetation. Non-oil and gas activities would need to occur within the Foreground-Middleground Zone of the viewshed in order to attract the attention of the casual observer.

A longer-lasting impact would be trails, sometimes referred to as "green trails," resulting from winter overland moves. Between 20 and 60 trains comprised of one to six vehicles and attached sleds could engage in overland travel each year. These trails form when vehicles compact snow and dead vegetative material, resulting in a greater availability of moisture and nutrients for underlying vegetation the following growing season. Visible trails would not necessarily develop over the entire route of the overland move. Vegetation could be damaged along these trails and the tops of tussocks could be scraped off, although current operating procedures would ensure that such damage was an infrequent problem. Trails would be visible for about 2 to 5 years, but some trails may be visible for longer periods of time. However, because they visually modify existing vegetation, rather than adding something foreign into the viewshed, trails would not produce much contrast to line, form, or texture. The color contrast would be minimal from ground view because of the natural variation in hue, and would be almost nonexistent from more than a few hundred feet away.

4.3.17.2 Oil and Gas Exploration and Development Activities

Effects of Exploration

Under Alternative A, five seismic surveys would occur. Seismic work would occur in the winter using cat trains with low-ground-pressure vehicles supported by light aircraft. Seismic crews would be housed in mobile camps consisting of a train of trailer sleds pulled by tractors along different trails. These moving camps and associated activities would result in short-term impacts on visual resources and the scenic quality of the area by creating color contrast between

the vehicles and trailers and the predominantly white background of the snow-covered landscape. These impacts would be confined primarily to the activity-site viewshed.

Trails resulting from seismic survey operations would result in a longer-lasting impact to visual resources. Unlike overland moves, seismic operations would not follow the same routes every year, and the number of miles of survey line could vary greatly from year to year. In some years, no surveys would occur. Like trails caused by overland moves, trails caused by seismic operations would not necessarily develop over the entire survey route, but where present would be visible for about 2 to 5 years, but some trails may be visible for longer periods of time. Approximately 250 miles (6,060 acres) of lines would be surveyed using 2-D seismic surveys, while approximately 10,560 miles (98,880 acres) of lines could be surveyed during each 3-D seismic survey, potentially resulting in several thousand miles of trails. Mobile camp trails could add another 840 miles (3,056 acres) of trails. Because trails visually modify existing vegetation, they would not produce much contrast to line, form, or texture. The color contrast would be minimal from ground view because of the natural variation in hue, and would be almost nonexistent from more than a few hundred feet away.

Approximately 151 exploration and delineation wells would be drilled under this alternative. Given the limited number of drilling rigs available, however, no more than five drilling rigs would likely be operating at any one time. Drill rigs (average height of 208 feet) would introduce strong vertical lines into a predominantly horizontal landscape. Because they are painted red, most drill rigs would also produce a strong visual contrast to the white background of the snow-covered landscape. Winter drilling requires lighting, which would create a visual contrast against the dark night sky. Drill rigs, because of their height, could be seen and attract the attention of the casual observer if they were located within the Foreground-Middleground Zone and Background Zone.

In addition to the impacts that would result from ongoing exploratory drilling operations, the greening of vegetation under vacated ice pads, ice airstrips, and ice roads would cause impacts to visual resources during the summer. This greening of vegetation would be caused by the same conditions that create "green trails," a greater availability of moisture and nutrients as ice or compacted snow melts. However, greening of vegetation would not necessarily occur everywhere ice facilities were constructed or snow was compacted. There would also be a "ring effect" around ice pads, ice airstrips, and ice roads caused by the death of vegetation adjacent to these snow and ice structures. Winter facilities inclusive of 151 ice pads (6 acres each), 20 airstrips (11 acres each), and 5,162 miles of ice roads (3 acres per mile) would result in as many as 16,768 acres that would be in various states of recovery from greening and ring effects under Alternative A. Because greening and ring effects visually modify existing vegetation, they would not produce much contrast to line, form, or texture. The color contrast would be minimal from ground view because of the natural variation in hue, and would be almost nonexistent from more that a few hundred feet away.

Dry exploration wells would be cut off and plugged below ground level and temporally leave only a small area barren of vegetation while exploration wells with production potential would leave behind a marker pipe (also known as a Christmas tree), which would likely be less than 6 feet tall and no larger than a square foot on the surface. This marker pipe would essentially be a permanent impact, but would be almost unnoticeable from several hundred feet away.

Effects of Development

Production rigs (two with an average height of 208 feet) would introduce strong vertical lines into a predominantly horizontal landscape. Because they are painted red, most drill rigs would also introduce strong contrast to the natural browns landforms and greens of the vegetation. In addition, burn-off flares and general work lighting would contrast against the dark night sky. Drill rigs, because of their height and color, could be seen and dominate the attention of the casual observer if they were located within the Foreground-Middleground Zone and Background Zone.

It is estimated that long-term surface disturbance from two staging areas (50 acres each), five pump stations (20 acres each) and five CPFs (90 acres each) would impact 650 acres. These facilities would introduce strong vertical lines from buildings into the landscape of predominately soft horizontal lines. There would also be a visual contrast between the simple, regular form of the buildings and the complex, irregular forms of the vegetation. Colors of buildings and materials would be in contrast with the greens, browns, and blues of vegetation and water bodies. Some of the buildings could be up to three stories in height above the tundra, and would attract and dominate the view of the casual observer if located within the Foreground-Middleground Zone.

Production pads (23 at 10 acres each), 230 miles of infield roads (1,783 acres), five airstrips (11 acres each), 11 gravel pits (50 acres each), and 230 miles of infield gathering pipelines (700 acres) would impact 2,818 acres. The gravel pads, airstrips and infield roads would generally be only 3 to 5 feet above the surrounding green tundra, and would be relatively unnoticeable beyond a few thousand feet. Infield gathering pipelines (4-10 inches in diameter) would introduce shiny and smooth horizontal lines into a natural landscape. They would also introduce regularly spaced vertical supports into an irregular horizontal landscape, but would be associated with other facilities within the disturbance area. Disturbance associated with gravel sites from borrow pits or below ground bedrock would generally occur below the ground surface, with only stockpiled materials being visible aboveground. While these sites could be large in size or footprint, very little material would remain as stockpile at any one time. Gravel mine sites from above ground bedrock locations may produce visual impacts if material is removed from rock outcrops within the planning area. This mining activity would change the form of the natural landscape and may be visible from the Foreground-Middleground Zone.

It is anticipated that as many as 162 miles of sales oil and main pipelines, impacting up to 491 acres (3 acres per mile), would be constructed under Alternative A. There would be no on-the-ground activities associated with sales oil and main pipelines, except during construction and repair. Sales oil and main pipelines (12-20 inches diameter) would introduce shiny and smooth horizontal lines into the naturally irregular brown and green landscape. They would also introduce regularly spaced vertical supports into an irregular horizontal landscape. All pipelines would be elevated at least five feet above the surrounding tundra, but could be elevated as high as 20 feet above ground level. At these elevations, pipelines would attract the attention of the casual observer if located within the Foreground-Middleground Zone.

Other facilities associated with development would include bridges and communications towers. If located within the Foreground-Middleground Zone, bridges, because of their contrast with smooth water bodies, and communications towers, because of vertical height above the horizon, would also be likely to attract the attention of a casual observer.

Vehicle traffic on roads during construction and other production activities would create short-term noticeable visual impacts through the creation of dust. These changes would be limited to the Foreground-Middleground Zone.

Effects of Abandonment and Rehabilitation

During abandonment and rehabilitation activities, vehicle traffic on roads would create short-term noticeable visual impacts through the creation of dust. Gravel pads and roads may or may not be removed and may or may not be revegetated with native species or other appropriate vegetative materials. Once closure and abandonment activities including revegetation are completed, the strong contrasts with the surrounding vegetation colors created by structures, such as pipelines and buildings, gravel pads, roads and airstrips would be eliminated. If gravel is not removed and not revegetated, long-term color contrasts would remain between the gravel areas and the surrounding natural vegetation.

Effects of Spills

Most small spills would be confined to a pad. Small spills not confined to a pad would usually be confined to the limited area immediately around the pad or pipeline, and usually impact less than five acres. With proper containment and clean-up, there would be no new visual impacts associated with small spills estimated to occur 1,792 times over the life of oil and gas activities in the planning area under this alternative.

Large spills, estimated to occur two or three times during the life of oil and gas activities in the planning area, would likely reach beyond the gravel pad and enter the environment. Impacts associated with visual resources would be to the surrounding vegetation and result in a contrast in color between the affected vegetation and soil, and the natural landscape.

Commercial Gas Development

Impacts to visual resources associated with surface disturbance and surface facilities for development and production of natural gas infrastructure would be similar to those described for oil development, though there would be no impacts from an oil spill. If natural gas production facilities are associated with existing oil infrastructure there would be some additional visual impacts associated with pipeline offset impacting additional acres if gas is transported on separate aboveground VSMs. If a gas pipeline is buried—considered the more likely scenario—there would be some change in line, color, and texture. These changes would result from the disturbance of irregular, predominately green, rough vegetation to a more regular, brown, smooth area of soil as seen within the Foreground–Middleground Zone. Facilities associated with a compressor station along a gas pipeline would introduce vertical, blocky, colored facilities similar to CPF structures into a predominately horizontal, green, irregular landscape and be visible within the Foreground-Middleground Zone and the Background Zone from some locations. These facilities would impact additional acres. Since Alternative A makes the least amount of lands available for oil and gas leasing, it is least likely of the alternatives to create these impacts.

4.3.17.3 Effectiveness of Stipulations

Although there are no lease stipulations specific to visual resources, lease stipulations designed to minimize impacts to solid and hazardous wastes; regulate overland moves, seismic work, and exploratory drilling; and regulate facility design, construction, and siting would reduce the

visual impacts that would occur under Alternative A. In addition, approximately 600,000 acres would be unavailable for leasing and development, further protecting visual values in the Teshekpuk Lake Special Area. Restricted Surface Occupancy (RSO) stipulations on approximately 825,000 acres will help reduce impacts to visual resources by restricting certain activities associated with exploration and oil and gas development (see Map 2-1).

4.3.17.4 Conclusion

Under Alternative A, as many as 11,650 miles of seismic and camp lines will impact 107,996 acres. Other temporary facilities such as ice roads, pads and airstrips, associated with exploratory drilling would impact up to 16,768 additional acres. Most of the combined 124,764 acres could be in various states of recovery from greening and ring effects. It is anticipated that up to 392 miles of pipelines would be constructed under this alternative, creating surface disturbance of up to 1,191 acres. There could also be approximately 3,318 acres of disturbance associated with gravel pads, roads, gravel sites, pump stations, staging bases, and Central Processing Facilities. Visual impacts associated with this alternative would be approximately 2.8% of the planning area. Approximately 600,000 acres would be unavailable to leasing and development around Teshekpuk Lake while another 825,000 acres would have Restricted Surface Occupancy (RSO) stipulations.

4.3.18 Economy

4.3.18.1 Activities Not Associated with Oil and Gas Exploration and Development

Recreational river rafting will occur in the planning area, primarily on the Colville River. BLM estimates (Table 4.2-A) up to 22 trips each made by four persons taking place each year. Employment generated by this activity would result from air taxi service and guide service. Neither of these services originate within the planning area. Air taxi services used for Colville River access originate in Bettles, Kotzebue, Fairbanks, and Coldfoot. Guides originate in Bettles, but may also originate from other locales in Alaska outside the North Slope, or may originate outside Alaska entirely.(Delaney 2007) Permitted commercial guided activities will result in fees to the Federal government. Operators or guides pay approximately $600 per year for BLM permits. BLM estimates their clients pay $1,200-$1,500 each for a trip.

Other activities such as research or surveys, various ground activities, and aircraft use not related to petroleum are shown in Table 4.2-A, Summary of Selected Non-Oil and Gas Related Management Activities. North Slope Borough residents may be employed in some of these activities, as will be other Alaskans and nonresidents.

4.3.18.2 Oil and Gas Exploration and Development Activities

Economic analysis of hydrocarbons in a geologic province is usually performed by establishing a statistical model of expected pool size variation in the province, defining generalized engineering parameters by pool size, and estimating financial costs of production for each engineering model at specified petroleum prices. Economically recoverable volumes include all pools where revenues would exceed costs using available technology, factoring in a reasonable return on investment. There are several uncertainties involved in the analysis. Specific pools are not identified and may require unanticipated engineering solutions to produce. Expenses may be higher or lower at the time of development, as the result of inflation, changing technology, more efficient practices, or other factors. The price of the product may be

substantially different from those used in the analysis. These uncertainties are addressed through the use of appropriate probability distributions in stochastic simulations, which result in a range of statistically defined outcomes. A component of this analysis would be the economic impact of management alternatives. This is the analysis that is presented in the Amended IAP/EIS.

For the Reasonably Foreseeable Development Scenario prepared in support of this Supplement, it was determined that a more transparent presentation of potential development characteristics should be presented. Economically recoverable volumes were divided by an economic standalone unit size to indicate a representative number of processing facilities expected in Northeast NPR-A over time. This is unrelated to the statistical expectation of pool size variation. Discounted cash flow (DCF) analyses were performed for each management alternative using the single development unit as the sole cost model, replicated by the number of units expected through the anticipated development timeline. This allowed the use of a Microsoft Excel spreadsheet model developed by MMS (Craig, 2001, rev 2004, corr 2006). While this is a simplified economic model, it allows a transparent presentation of the accounting performed to arrive at estimated economic impacts presented in this Supplement, without overwhelming the reader with complexity or divulging proprietary cost information.

In the simplified DCF, general information such as to base year, inflation rate, discount rate, and tax rates are entered onto the summary worksheet. This sheet also lists gross estimates for various drilling and construction capital and operation costs. The next worksheet contains a price forecast. The third worksheet contains the drilling, construction, and production schedule. The fourth computes ad valorem property taxes under Alaska laws. The final sheet is the year-by-year computation of revenues, expenditures, and taxes to determine cash flow. These cash flows are discounted to present dollars, with the more relevant results brought forward to the summary worksheet. These results are used to compare the direct economic effects of management alternatives, and do not rise to the level of an accounting forecast. Only the unrisked analysis has been performed, since this is for the planning area rather than an individual field, diluting the risk of not finding an economic field.

According to this model, oil production will begin about 2019 in all alternatives. In Alternative A, exploration, development, and production are assumed on existing leases or on tracts previously not leased. Oil and gas exploration and development activities will increase revenue and employment. Peak production in this alternative is calculated at 73.5 million barrels in 2051, and in 2061. By these dates, up to 5 central processing facilities will be in operation. We indicate revenue for 2021 as it is the first year of substantial production for all alternatives (31.9 MM bbl). We also show estimated revenue for 2045. (See Table 4.3-B) The fields will continue to produce and probably incur other development beyond this time. It is in the future that revenues and employment begin to differ among alternatives, as variation in development and production manifest.

Revenues

There are several revenues resulting from oil leasing and production. Bonus bids are monies received for the right to lease parcels offered. Bids vary directly with the likelihood of resource value. Bonus bids for Federal leases in NPR-A are shared with the state. State property taxes are assessed at the rate of 2% on the value of production and transportation hardware. A royalty is based upon the Federal royalty rate of 16.67%. By law (42 U.S.C. § 6506a), the State and Federal governments share the NPR-A royalties equally. And, the state must give a portion of the royalties to local government, in this case NSB. State corporate income tax at 3% was

used in these calculations. Federal corporate income tax is 35%. State severance tax is assessed as a percentage of production value of the product at the well head after cost of production and transport are considered. In 2006, the severance tax rate was raised to 22.5%, and the calculation of wellhead price also changed to include more of the cost of production. However, regulations implementing these changes are not complete. Calculations here are based upon the earlier version of the tax code, and are offered for comparative purposes. Previous revenues from NPR-A are mentioned in **sections 3.1.1.1, 3.1.1.3, and 3.1.1.4**.

Bonus bids, estimated to be $10 million, will be lowest for this alternative as no new area will be opened to leasing. Exploration, development, and production activities are estimated to generate property tax revenue to the North Slope Borough of up to $40 million early in the life of the operation. As capital is depreciated, revenue from each field will decline. Other local, state, and Federal revenues are also anticipated to increase under Alternative A. Royalty payments split equally by the State of Alaska and the Federal government may be as high as $1.1 billion by 2045. State Income Taxes will reach approximately $89 million, and Federal income tax just over $1 billion. In addition, $606 million in state severance taxes could be generated. All estimates are based upon average imported crude oil prices in 2005 dollars from the Annual Energy Outlook 2007(Energy Information Administration, 2007).

Table 4.3-B. Alternative A Revenues (in millions of 2005 dollars)

Alternative/ Revenue	Bonus Bids	Royalty		Property Tax		State Tax		Federal Tax		Severence Tax	
Year		2021	2045	2021	2045	2021	2045	2021	2045	2021	2045
A	10.0	325	1,193	40	225	30	89	338	1010	165	606

Employment

The number of workers needed to operate the infrastructure would be determined by the scale of the infrastructure, and level of effort exploring and developing a field, and to a lesser extent by the amount of oil produced. A wide range of production volume would be handled by a given level of infrastructure. Once the infrastructure was in place, the number of workers needed to operate it would not depend on the amount of product flowing through it. In contrast to the Northeast NPR-A Amendment, development as well as oil production is not expected to peak as quickly. The lease development schedule for this EIS is aggressive, however, and the number of exploratory wells drilled annually depends upon availability of drilling rigs.

For the purposes of this analysis it is assumed that about ten years of exploration, proving, permitting, facility construction, and development drilling precede initial production. It is also assumed that development of multiple CPFs will not occur simultaneously, but instead occur approximately ten years apart (Figure 4-4). This assumption takes into account the remote location of the planning area, the availability of equipment and personnel on the North Slope, regulatory requirements, and anticipated pipeline capacity. There is considerable economic benefit in bringing production online gradually to assure long-term maximum utilization of pipeline capacity. It is also assumed that development of each satellite would take about two years, allowing for a complement of satellites to be on-line before the next CPF is constructed to maximize sales pipeline throughput. It is possible, however, that several large finds are made and developed in a short period, or that no economic finds are made for a period extending beyond ten years, delaying the development of a new CPF.

It is expected that exploration will begin immediately after leases are acquired. The survey effort is expected to be the same for all alternatives. In this alternative we expect five exploratory wells each year in six year increments as a field begins. Additional fields will also be delineated by exploratory wells ten to thirty years initial activity. Therefore, long before exploratory drilling is complete, development wells, central processing facilities, roads, pipelines, airstrips, will be under construction.

Survey crews will be employed for the first two winter seasons beginning as early as 2008. BLM estimates 40-60 personnel will be on each crew. This activity will occur at the same time and intensity in each alternative. In this alternative, BLM estimates five exploratory wells will be drilled with five crews each year for 5 years beginning in 2010. Exploration drilling will employ crews of up to 120 workers (using 2 drill rigs) beginning in 2010. By 2017, development wells will be added at the rate of 10 the first year, and up to 36 in any one year. Wells are drilled from the pad with a central processing facility (CPF) due to be in operation eight years after drilling begins. Upon completion of the CPF gravel pad, drilling development wells may continue throughout the year. BLM estimates 30 to 60 personnel are required to drill each development well. Crews are required for construction all facilities. In 2016 this may reach 600 personnel as infrastructure and facilities construction is undertaken. Gravel roads, flowlines, sale lines and other infrastructure will be added as the first CPF comes on line. Initial production is expected in approximately 2019. CPF operation requires 360 to 480 workers on two shifts.(Rothwell 2007) Sixteen development wells, 10 miles of gravel road, and 10 miles of flowline are also constructed the same year. Under this and other alternatives, additional fields, CPFs, and associated infrastructure are added incrementally over many years. Therefore, exploration, development, and production employment overlap greatly. Production employment will not appear distinctly as the only employment component for many years. The employment spread during selected years may appear as such:

Table 4.3-C. Potential Employment for selected years under Alternative A

Tasks/Alternative	Year	Total Direct	Total Indirect	NSB Direct	NSB Indirect
Survey	2008-9	40-60	120-180	3-4	5-7
Exploratory well drilling	2010-15	150-300	450-900	11-21	19-36
CPF, and infrastructure construction	2016	400-600	500-750	36-54	25-37
CPF operation development well drilling, sale line construction	2017	500-680	630-860	35-48	25-34
Pad, development wells, road, pipe, 3 CPFs in operation, CPF under construction	2045	1,500-3200	1,890-4,030	105-225	75-160

It is anticipated that total NSB resident employment would capture approximately 8% of exploration and development jobs and about 3% of the production jobs (BLM 2005).

BLM also estimated total indirect and induced employment to be as high as 300% of the exploration direct employment and about 130% at development and production stages. NSB indirect and induced employment was estimated to be about 170% of NSB direct employment during exploration, 68% during development, and 86% during production (BLM 2005).

During the last decade, 25% to 29% of Alaska's oil industry workers have been non-residents of this state. These workers commute from outside Alaska, and do not generate measurable induced employment in Alaska. The economic impact of nonresident employment on the U.S. is negligible for all alternatives (Fried and Windisch-Cole 2003).

Commercial Gas Development

Natural gas development and production from the NPR-A would generate additional employment. Construction of pipelines would provide substantial numbers of construction jobs for the winter seasons of installation. It is likely that a portion of construction workers would reside in the NSB. Once in operation, gas development would not result in substantial increases in employment over that associated with oil production. However, if gas development occurs as oil production is decreasing or ceasing, the addition or shift to gas production may prolong employment from planning area petroleum production. Development would generate additional property taxes and royalty income for the NSB and State, more severance taxes for the state, and additional royalties for the Federal government. To the extent that industry is attracted to bid on leases for their gas rather than oil production potential, gas development opportunities could increase interest and bid amounts at lease sales within Northeast NPR-A, providing additional revenues for the Federal and state governments. Alternative A offers less land for oil and gas leasing than the other alternatives, so it is anticipated to have less impact on employment and revenues than the other alternatives.

4.3.18.3 Conclusion

Oil and gas exploration and development would benefit the economy be creating increased revenues and employment. By 2045, approximately $225 million would be generated annually in property taxes. There would be an annual royalty of $596 million for the Federal government, and the same amount for the State of Alaska and the NSB. The number of jobs created by exploration, development, and production would reach 3,390 to 7,230 during 2045. The number of NSB resident jobs generated would be 175 to 385 at that time. Disruptions to the harvest of subsistence resources could affect the economic well-being of NSB residents, primarily through the direct loss of subsistence resources.

4.3.19 Public Health

Decades of testimony and written comments by North Slope residents and organizations has demonstrated a longstanding concern regarding the potential impacts of oil and gas exploration and development on public health. Recent communications between the BLM, ICAS, the North Slope Borough, the Alaska Inter-Tribal Council, and the EPA indicate that with the expansion of plans for leasing, exploration, and development onshore and offshore, in terms of both the number of proposals and the area involved, public health is becoming an issue of increasing importance for potentially affected communities. This section was developed as a response to these concerns.

Methodology

The effects analysis for public health utilizes the principals of "Health Impact Assessment," (HIA) as defined by the World Health Organization (World Health Organization 1999). HIA draws on public testimony, literature review, and accepted mechanisms of health and illness to establish the scope of health concerns which should be considered. Detailed comments in response to the notice of intent for this Supplement synthesizing the pertinent data were submitted jointly by the Alaska Inter-Tribal Council and NSB. For the analysis of the potential health effects, the available public health data, literature from analogous populations, accepted mechanisms of health and disease, and the effects analysis for other resources are synthesized to generate a model, or "logic framework" which guides the analysis. The results of the analysis are then subjected to peer review by public health professionals.

4.3.19.1 Activities Not Associated With Oil and Gas Exploration and Development

Non-oil and gas activities include use of aircraft and watercraft, scientific research and data collection, recreation, overland moves, and solid and hazardous waste removal and remediation. Under Alternative A, these activities should not increase in frequency, would be of short duration, and would occur in limited areas. Research and data collection could result in the diversion or deflection of subsistence resources where helicopter or fixed-winged aircraft were used, which could result in local and temporary disruption to subsistence harvests of these resources, and an altered or degraded experience of the land for Inupiat hunters in the region. Archaeological research could increase interest in Iñupiat cultural history; however, some members of the community might oppose archaeological research for religious or cultural reasons. Recreational uses, primarily rafting and bird watching, would generally occur during the summer along rivers such as the Colville and Ikpikpuk, which could create localized and temporary effects (e.g. user conflicts and subsistence resource deflection), that would last only as long as these users were in the area. Overland moves are, in some cases, necessary for supplying communities with bulky goods and fuel, as well as for moving scientific and other camp equipment during the winter using low ground pressure vehicles, and are subject to the restrictions placed on such activities in the lease stipulations (USDOI BLM and MMS 1998). However, non-oil and gas overland moves are uncommon.

Overall, these localized and temporary effects could have impacts on individual health outcomes, but would be unlikely to lead to significant overall changes in community health. For example, local conflicts with individual subsistence users, interruption of family life in camps, loss of privacy and feelings of being 'invaded,' and temporary deflection of subsistence resources might all increase stress and frustration for the impacted individuals; stress is known to be associated with maladaptive coping, such as drinking or violent behavior, and the risk of this might increase in individual cases. Deflection of subsistence resources might lead to longer and more difficult hunts, exposing individual or small groups of hunters to a higher risk of injury. Local emissions or dust might temporarily affect air quality, which in turn might exacerbate an individual's asthma if traveling in the area. Food insecurity and hunger are also possible concerns: Inupiat families depend heavily on subsistence resources in the planning area, and it may not always be possible to replace subsistence foods with store-bought foods. Sharing networks generally help provide for the needs of families who have not been successful harvesting food, but if the disturbances to subsistence affect multiple families, hunger could result.

On an individual basis, such events could be highly significant. But because the activities not associated with oil and gas development are expected to be short term, localized, and sporadic, they would not be expected to result in overall population health changes.

4.3.19.2 Oil and Gas Exploration and Development Activities

Effects of Disturbances

1. Diabetes, Hypertension, and Associated Metabolic Disorders

Diabetes, obesity, hypertension, and hyperlipidemia (collectively termed metabolic disorders here) are among the main risk factors for cardiovascular and cerebrovascular diseases (among the leading causes of death and disability in the NSB), renal failure, and peripheral vascular disease. Metabolic disorders are disproportionately common in American Indian/Alaska Native (AI/AN) groups compared with the U.S. population. However, rates of diabetes in the North Slope Inupiat are among the lowest in the U.S., including among non-natives (Naylor et al 2003; Bjerregaard and Jorgensen 2004; Zinman.)

The subsistence diet is the most important protective factor among AI/AN groups against metabolic disorders. Numerous studies have demonstrated that the risk of developing metabolic health problems increases as the proportion of the total dietary intake from subsistence foods decreases (Murphy et al 1997; Young et al 1992; Bjerregaard, Young et al 2004; Bjerregaard, Jorgensen et al 2004.) AI/AN groups are thought to have a particular genetic susceptibility to diabetes, such that it occurs at much higher frequency than in the non-Native U.S. population when AI/AN people transition to a more "typical" U.S. diet. Other studies have noted that the quality of food available in village stores in rural Alaska tends to be low and the expense of buying more nutritious food (such as whole grains, fruits, and vegetables) is often prohibitive, such that when subsistence resources are unavailable, obtaining a higher percentage of calories through local stores reduces the nutritional value of the diet, and places people at higher risk for developing metabolic disorders (Bersamin and Luick 2006, Kuhnlein H and Receveur 2002). North Slope annual per capita subsistence harvest figures are among the highest in the state, and diabetes rates at present are among the lowest, although recent years have witnessed a substantial increase (Alaska Department of Fish and Game 2000, Naylor and Schraer 2003).

State and local health officials, the Alaska Native Tribal Health Consortium, the Alaska Native Health Board, and the North Slope Borough Department of Wildlife Management have all engaged in studies which have helped to document the health benefits of a subsistence diet, and all are actively engaged in promoting the nutritional importance of subsistence foods for public health.

Thus, under Alternative A, diabetes and metabolic disorders would be expected to increase if impacts to subsistence led to declining subsistence harvests (either through declining populations of subsistence resources, displacement of resources making hunting less successful, or displacement of hunters by oil activity and infrastructure).

The likelihood of subsistence impacts under Alternative A is discussed in **section 4.3.12**. Nuiqsut, Atqasuk, and Barrow would be the most impacted, as these villages obtain most of their caribou from the TLH; Wainwright and Anaktuvuk Pass also depend heavily upon the TLH. Nuiqsut harvests a majority of its fish from the Fish and Judy Creeks and Colville Delta portions of the planning area; Barrow and Atqasuk also harvest a portion of their annual fish from lakes and drainages in the planning area. Nuiqsut-harvested fish are also shared among

these villages. Caribou and fish represent two of the most heavily harvested resources, and hence impacts to harvest success for any of the villages which depend on the planning area could lead to the need to replace subsistence resources with store-bought foods.

Development under Alternative A would be located in Nuiqsut's primary subsistence use area. Nuiqsut residents could experience further limitation in their hunting range to the South and West of the village. Development in the planning area could divert subsistence resources and users, decrease the use of traditional harvesting areas and camps, and lower the quality of and connection to the land.

As stated in **section 4.3.13.2**, this disconnection from traditional uses could threaten not only harvest success, but the viability of the subsistence way of life that is a major component of Inupiat culture and a foundation of health. Dietary change would thus occur not only through decreased harvest success, but also potentially through a cultural shift away from reliance on subsistence. If this occurred, residents could face a substantial increase in diabetes and metabolic disorders, likely resulting over the long term in increases in cardiovascular mortality, renal disease, peripheral and cerebrovascular disease, and other related complications. Modernization and younger age have been found to be risk factors for decreased consumption of subsistence foods in Inuit populations (Schraer and Bulkow 1993; Curtis, Kvernmo 2005; Nobman, Ponce et.al, 2005; Condon et al 1994). Hence, although subsistence has continued to hold its importance as a cultural value, there is a tendency toward subsistence foods making up a lower percentage of the total caloric intake. Oil and gas activity is not the sole factor placing communities in the planning area at risk for diabetes and metabolic diseases, but rather may contribute adversely to an already established trend.

Oil and gas development may also have effects which facilitate subsistence. Studies have documented that the increased income in North Slope villages has provided capital to purchase equipment which allows more effective and efficient hunting (Kruse and Braund, in press). To the extent that the proposed action tends to increase income, either through direct employment by industry or through the generation of tax revenues that enable the NSB to maintain or increase current local employment levels, this might offset adverse impacts of development activities by facilitating subsistence harvest, which might offset the adverse effects on subsistence described above.

<u>2. Food Insecurity and Hunger</u>

Food insecurity and hunger are considered to be severe health problems separate from the ultimate potential outcomes of severe malnutrition and starvation. Even in early stages, both food insecurity and hunger are associated with significant psychological dysfunction, learning problems, poor self-reported health status, poor overall functional status, and increased likelihood of chronic illness; food insecurity is also paradoxically associated with being overweight in some studies, likely owing in part to the extremely poor nutritional value of many low-cost convenience foods (Olson 1999; Vozoris and Tarasuk 2003). These effects persist even after adjusting for potentially confounding variables. In the U.S., food insecurity affects an estimated 11% of households, and hunger affects roughly 3.4% of households. In Alaska, food insecurity impacts roughly 11.7% of households, and hunger affects 4.6% of households (Food Research and Action Center, 2006). There are no regional data available. However, although geographic and political differences prevent an accurate comparison, evidence from Canadian Inuit found a markedly elevated prevalence of food insecurity, at up to 49%, owing to their remoteness, dependence potentially unreliable harvests of wild foods (both similar to Inupiat), and poverty (a less significant problem on the North Slope) (Chan et al. 2006).

Wild foods account for roughly 50% of the caloric intake in the Alaskan Arctic, averaged over the population, and provides well over 100% of protein requirements. In 2000, the monetary value of this harvest was estimated at between $31 million and $53 million, if suitable meat were purchased in its place (ADF&G 2000). Consequently, the potential of impacts to subsistence is a likely cause of food insecurity for North Slope villages, and actual impacts to subsistence would be expected to lead to an increased prevalence of hunger. Whereas diabetes and metabolic syndromes may develop over the course of years, the problem of hunger is more immediate.

Under Alternative A, development could impact subsistence resources, particularly for Nuiqsut. The potential of impacts to caribou and fish in the planning area would be a substantial cause for food insecurity, but the preservation of subsistence range through setbacks and RSO restrictions in some of the most productive areas would mitigate this effect. Hunger would be unlikely, but could be a problem if families experienced failed efforts to harvest key resources. Sharing networks can mitigate hunger, but if impacts to subsistence were substantial, the sharing networks might not be capable of meeting the entire caloric requirements of impacted families.

3. Social Pathology (assault, alcohol and drug abuse, domestic violence, suicide, and homicide)

Health problems associated with social pathology include hospitalization and mortality from unintentional injury (secondary to alcohol and drug abuse, abnormal risk-taking, or suicidal behavior), intentional injury (suicide and homicide, assault), and alcohol and drug abuse. A large body of literature has documented the general association between modernization in circumpolar Inuit communities and social pathology (Curtis T, Kvernmo S et al 2005; Bjerregaard 2001; Shepard and Rode 1996; Travis R 1984). However, some Alaskan data suggest that well-developed and adequately funded political and social systems can allow communities to channel effects and economic gains toward more positive social outcomes (Haley 2004).

Under Alternative A, impacts to sociocultural systems and subsistence could increase adverse health outcomes related to social pathology. As discussed in **sections 4.3.12 and 4.3.13**, if subsistence foods were not available from Nuiqsut or other communities, it could be necessary for hunters from Anaktuvuk Pass and Wainwright to travel outside of traditional harvest areas to harvest subsistence foods, which would increase the difficulty, expense, and risk of traveling to subsistence harvest areas. As a result, there would be an increase in social stress, as hunters would leave the community for longer periods to harvest resources, possibly with less success. Indirect effects could include increased competition for subsistence resources with other communities, a change in subsistence emphasis to other resources (e.g., sheep, moose, and fish), decreased self-sufficiency, and changes in relations with other Iñupiat communities.

Staging for oil and gas activities in the planning area would occur primarily from facilities at Prudhoe Bay/Deadhorse, Kuparuk, and other existing sites, which would reduce disruption to nearby Native communities. A trend toward displacement of community social institutions could lead to a short-term and decreased emphasis on the importance of the family, cooperation, sharing, and subsistence as a livelihood. Increasing oil and gas activity could increase access to urban communities and cause more interaction with oil-industry workers, resulting in the introduction of new values and ideas as well as increased racial tensions and an increased availability of drugs and alcohol. Tensions would be created and could result in increasing problems of maladaptive behavior and family stress, potentially straining the ability of traditional Iñupiat institutions to maintain social stability and cultural continuity. Feelings of

loss, frustration, and disempowerment because of the continued expansion of development despite intensive efforts to protect the core of subsistence traditions and lands could heighten this stress and frustration. These effects could impact health outcomes as follows:

Access to Alcohol and Drugs

Access to alcohol has been shown to increase adverse health outcomes related to social pathology in remote Alaska Native Villages (Wood and Gruenewald 2006; ANTHC 2006; Chiu and Perez 1998). Consequently, all North Slope villages but Barrow ban the possession of alcohol; in Barrow there is a ban on sale but not possession. Other data have suggested that adequate police support in villages can substantially improve social stress (Martin 2005). Increasing oil and gas activity could increase access to urban communities, add to the influx of workers into the region, and cause more interaction with oil-industry workers, resulting in the possibility of increased availability of drugs and alcohol. Residents in Nuiqsut have commented on this problem in public testimony:

> We had a lot of problems with alcohol and drugs this whole year. We were lucky to get a third officer's position. Unfortunately, our community is also being labeled poorly because of this. A lot of it came through the ice road and through various means. We had a guy hitch a ride on a truck that came in to deliver either diesel or something of the sort that related to the development, who brought in all sorts of drugs and was selling them out of the camp. There was at least three that we know of in the last month. (Ahtuangaruak 2001)

Subsistence Impacts

Perceived and actual threats to subsistence constitute a significant source of ongoing stress and tension in North Slope communities. Under Alternative A, subsistence resources and areas might be impacted; displacement of caribou and hunters away from oil infrastructure may result in longer travel times and less successful hunts. Regardless of the degree to which these impacts occur, resident anxiety over the potential challenge to the ongoing viability of their traditional diet and way of life and feelings of disempowerment or loss of control over the resource development decision process can contribute substantially to individual and family tension, which would exacerbate social pathological health outcomes. Speaking about this problem, one Nuiqsut resident said:

> When our people can feed themselves, they're very happy. They don't care if they don't have a job as long as they're providing for their families, as long as they have the hope in their mind of the possibility to provide for their families. You take away that hope, and you're going to have many, many people that we lose to the ills of social ills. (Rosemary Ahtuangaruak, in MMS 2001).

Employment

Increasing employment is generally associated with lower rates of social pathologies, but the data pertaining to this question in the Inupiat are complex. For example, one study correlated high suicide rates in the NWAB with rapid sociocultural change in the context of a period of decreasing employment opportunity (Travis 1984). Another study, however, found that in Inupiat communities, increased employment was not always associated with improved well-being, because of the tensions created between work and subsistence (Martin 2005). However, most North Slope residents tend to view employment opportunities as a positive.

Under Alternative A, it is anticipated that total NSB resident employment would increase in the range of 42 to 44 jobs in the peak of development and level off to 17 to 27 jobs during production after 2017. Hence, employment would exert a fairly small effect on social pathology.

Economic Development

Economic development has generally been found to have positive effects on rates of health problems linked to social pathology. The moderate projected revenues from Alternative A (see **section 4.3.18**) could provide ongoing revenue to stabilize economic institutions, support services and infrastructure, including public health, and maintain or increase the present standard of living, all of which would be expected to have beneficial effects on social pathology (Haley 2004, Travis 1984). However, large infusions of capital can have disruptive effects on social organization as well. An example has been described anecdotally by researchers in Nuiqsut. In this case, an increase in income disparity is felt to have resulted from Kuukpik corporation revenues which increased as a result of the Alpine project, leading to substantial increases in income disparity between Kuukpik shareholders and non-shareholders, and consequently in tension and resentment within the community (Galginaitis 2006). Similarly, individual employment may contribute to greater relative income disparity between employed and unemployed members of the community. Since Alternative A is not expected to result in a large percentage increase in income to any community in the region, this effect is likely to be small.

Sociocultural Change

Rapid sociocultural change is well-established as a cause of social pathology and related health problems in Arctic Indigenous populations (Curtis, Kvernmo et al 2005; Bjerregaard 2001; Wexler 2006). Under Alternative A, increased interactions with oil workers could result in the introduction of new values and ideas as well as increased racial tensions. Project-specific disturbances, such as large numbers of transient workers entering a village, and displacement and disruption of traditional hunting areas, may lead to feelings of disempowerment among residents wishing to protect their traditional way of life; ambivalence among the youth, who must resolve the tensions between attachment to traditional Inupiat life and non-Native value systems, communication styles, diet, and lifestyle; and domestic tensions as family providers feel pressure to be both successful hunters and economic providers. Tensions would be created and could result in increased incidents of socially maladaptive behavior and family stress, potentially straining the ability of traditional Iñupiat institutions to maintain social stability and cultural continuity.

These are changes which are already well established on the North Slope. However, as discussed in **section 4.3.13**, Alternative A could result in substantial local acceleration of sociocultural change through the disturbances including but not limited to the influx of temporary personnel from outside the region, new industrial infrastructure on traditionally valued lands, conflicts between local increases in job opportunity and the need to subsist, and infusion of capital to the community via revenues to the village corporation.

<u>4. Injury Rates</u>

As summarized in **section 3.4.10**, injury is the second leading cause of death in the North Slope, and the leading reason for non-obstetric hospitalization. Figures from the Alaska Trauma Registry indicated that the hospitalization rate for injuries on the North Slope was the highest in the state, at 141/10,000 residents, and over twice the state average. Alcohol has been

estimated to be involved in up to 40% of injuries and traumatic deaths in Alaska Natives (ANTHC 2006). Suicide rates are estimated at roughly 45/100,000; unprocessed arrest data show rates of rape and assault from 8-15 times the U.S. rate; the age-adjusted mortality rate for unintentional injury is 112/100,000, compared with 36/100,000 in the U.S. (Day et al. 2006; US Department of Health and Human Services 2006).

Under Alternative A, injury rates could be affected through two pathways:
(i) Displacement of subsistence animals resulting in the need to travel longer distances in more difficult conditions.
(ii) Social pathology leading to increased rates of alcohol and substance abuse (as discussed under "social pathology" above), and the resultant predictable increases in unintentional and intentional injury.

The degree to which injury rates may increase will depend on numerous factors, including:
(i) The amount of illicit drug and alcohol trafficking which results from increasing access between the communities and the road system, and by the influx of outside workers.
(ii) The frequency and duration of contact between residents and transient workers.
(iii) The degree to which subsistence resources are displaced, creating more difficult and dangerous hunting conditions.
(iv) The degree to which the project-specific disturbances to the traditional range of the impacted villages generates stress and maladaptive behavior.

5. Health Problems related to EPA Criteria Pollutants

Airborne emissions from oil and gas activities include the EPA "criteria pollutants" (NOx, SO_2 PM_{10}, $PM_{2.5}$, ozone, lead, and CO), which have been associated with an array of health effects, the most common and significant of which include causing and exacerbating respiratory illnesses such as asthma; increased risk of cardiac arrhythmias; exacerbated atherosclerotic coronary artery disease; and excess overall mortality rates among vulnerable groups. According to the EPA, $PM_{2.5}$ in particular is associated with "increased respiratory symptoms, such as irritation of the airways, coughing, or difficulty breathing, for example; decreased lung function; aggravated asthma; development of chronic bronchitis; irregular heartbeat; nonfatal heart attacks; and premature death in people with heart or lung disease" (EPA 2005).

Current air quality assessments on the North Slope are based on scientific judgment and limited modeling. Both EPA and the State of Alaska have established legal limits for air pollution based on scientific evidence, known as Ambient Air Quality Standards, to protect public health, including the health of sensitive populations such as asthmatics, children, and the elderly. However, according to EPA analysis and several independent studies, substantial health effects accrue at even levels below NAAQS standards, down to ambient levels (Ostro et al 2006; USEPA 2006b). The health effects include higher overall mortality rates and higher loss of 'quality adjusted life years,' a measure which takes into account time lost from illness. From the standpoint of the North Slope population, one of the most important findings of these data is that the impacts fall disproportionately to vulnerable populations (elderly, very young, and people with chronic illnesses). Given the baseline health disparities described in **section 3.4.10**, then, North Slope communities would face substantial risk from increased particulate emissions, even if air quality continued to meet NAAQS standards. The state of Alaska, however, has not yet adopted a standard for $PM_{2.5}$, for which the EPA established regulatory criteria more recently. The deadline for the state to adopt new $PM_{2.5}$ standards is December 2007. Consequently, there are no data available for $PM_{2.5}$ levels on the North Slope.

The NSB has expressed very strong concerns that the models used to predict air quality on the North Slope have not been adequately validated, particularly in view of the arctic climate conditions. The NSB and AI-TC have further asserted that, because of the health disparities and vulnerabilities in North Slope villages (including the high prevalence of certain cancers and pulmonary disease, as described in **section 3.4.10**), it is critically important to establish a scientifically robust monitoring program to validate the current predictions.

If, however, current modeling (as described in **section 4.3.1**) is correct in that contributions to decreased air quality from oil and gas development under this alternative will be low, the overall impact to human health airborne emissions under Alternative A would be likely to be low as well. Air quality impacts near the areas of potential oil and gas development are likely but, because of the distance of predicted development from most population centers, substantial reductions in village air quality are unlikely.

6. Health Problems Related to Other Contaminants

For many years, North Slope residents have expressed concerns regarding the potential contamination of the environment and subsistence foods by local industrial development, and the potential human health consequences. Environmental contaminants may enter the human environment through airborne emissions (as discussed above), liquid and solid-phase discharges such as drilling muds, and spills, and other pathways of water fouling. Airborne contaminants (other than the Criteria Pollutants discussed above) are categorized as Hazardous Air Pollutants (HAP), a diverse group of pollutants with an array of health effects including an etiologic role in certain cancers, cognitive and neurodevelopmental delays, endocrine disorders, and immunological problems (Jacobsen et al 1996; EPA 2007; AMAP 2003; Cone 2005). HAP can contact human populations either directly through emissions, or through the food chain. Data from other communities in which the "total petroleum hydrocarbons" concentrated in water (from air and waterborne sources) has documented a correlation between proximity to oil and gas exploration and production and health outcomes, including cancer and miscarriages (San Sebastian, Armstrong 2001, 2002; Hurtig, San Sebastian 2002). However, the small size of the North Slope population and the bioaccumulation of contaminants from worldwide sources render precise attribution of the contribution of local industrial activity to contaminant-based health problems extremely difficult, outside of a scenario such as large-scale contamination occurring through a large oil spill.

Common HAP emissions related to oil and gas development, such as benzene, toluene, ethlybenzene, and xylene all have significant adverse health effects, well documented by EPA. HAP are a source of great concern for North Slope residents, who feel that their exposure to contaminants is likely to be significantly greater than the general population because of their extraordinarily high rates of consumption of fish and game which feed in the region. The NSB has formally requested, consequently, that Industry be required to utilize the Maximum Achievable Control Technology on all HAP emissions sources in the planning area, including rigs and exploration sources. The NSB has further suggested that producers should use the cleanest possible fuel sources, such as natural gas (which is readily available on the North Slope), or low-sulfur diesel to protect the health of local inhabitants, subsistence resources, and the environment.

The NSB has maintained an extensive program of monitoring and testing subsistence resources for contaminants. The results have been encouraging, in that to date, the levels of contaminants such as PCBs in subsistence foods have been substantially lower than those reported in similar resources in Canada and Greenland. One important study also documented the presence of PCBs in store-bought foods, and made the point that there is no available food

source which prevents exposure to such contaminants altogether (O'Hara 2005). The Alaska Department of Health has also summarized data on PCBs and mercury in subsistence foods, and concluded with a strong recommendation that people continue eating subsistence foods because given the relatively low levels of contaminants present, the health benefits clearly outweigh the risks (Alaska Department of Health 2004a and 2004b). A 1999 report by the Alaska Native Health Board: Alaska Pollution Issues assessed the risks from radionuclides, persistent organic pollutants, heavy metals, polychlorinated biphenyls, dioxins, and furans, and concluded that the "benefits of a traditional food diet far outweigh the relative risks posed by the consumption of small amounts of contaminants in traditional foods" (Alaska Native Health Board, 1999). There are few data, however addressing water or air concentrations of many contaminants in the region, nor are there data regarding levels of these contaminants in the human population.

The lack of a demonstrated link between environmental contamination by local industry and specific health outcomes should not be interpreted as evidence that there is no reason for concern. The testing programs are not extensive enough to determine local variations in the concentration of contaminants near industrial developments. As many residents have pointed out, the established safety levels for many contaminants are based on consumption amounts in the general population, which may consume only a tiny fraction of the fish or game consumed by North Slope subsistence families.

In Alternative A, development would occur in parts of one of the most important subsistence lands in the North Slope region. Although data support the conclusion that the overall benefits of maintaining an active subsistence lifestyle, culture, and diet outweigh the unproven risks posed by contaminants, data are not sufficient to allow projection of the potential incremental increased risk posed by contaminants associated with exploration and production facilities. Particularly in view of the large quantities of subsistence foods consumed, this is an issue worthy of further investigation and monitoring.

7. Infectious Disease

As outlined in **section 3.4.10**, the prevalence of pulmonary disease is high; rates of HIV and syphilis are substantially lower in the North Slope than in the Alaskan and U.S. general population (Alaska Department of Public Health 2002 and 2005); Chlamydia rates are much higher in Alaska Natives than non-Natives in Alaska – there are no north Slope-specific data available at this time (Alaska Department of Public Health 2006). In our discussions with health care providers in the region, many commented that the North Slope community appears particularly vulnerable to respiratory infections. This observation has been made in other coastal Alaska Native populations as well (Singleton, Bruden et al. 2006).

Under Alternative A, the influx of oil industry workers from communities far outside of the North Slope region could pose a risk of infectious disease transmission. Transmission of respiratory infectious would be of greatest concern to vulnerable members of the community, including people with chronic illnesses and elders. Under Alternative A, an influx of personnel from outside of Alaska – where HIV and syphilis rates are generally substantially higher – could expose villages to a significant risk of increased incidence of these diseases. The NSB health department has tried in the past to address this problem though sending boxes of condoms to oil camps near villages, but existing resources in the NSB have not allowed a more coordinated public health effort to study or monitor transmission rates, nor to develop a more detailed public health approach to prevention. Diarrheal illnesses, common in groups of workers living and working in small enclosed facilities such as oil camps, could also pose a threat if infection spread to the community.

8. Social Determinants of Health

Much of the analysis of the potential health impacts of oil development depends on an understanding of the complex interplay between socio-economic, cultural, and environmental factors. The following discussion should be viewed as a way to provide context to the specific health outcomes discussed in detail above. As discussed in **section 3.4.10**, the social determinants of health underlie many of the current disparities between AI/AN health and the health of the general U.S. population (Wilkinson R, Marmot M 2003; Alaska Department of Public Health 2001). The social determinants of health comprise measurable factors which describe social, cultural, and economic differences between subgroups in a population. The large-scale social and economic changes associated with oil and gas development in the vicinity of small indigenous communities can have marked impacts on these health determinants.

The analysis of health impacts through the social determinants framework allows identification of both adverse and beneficial aspects of development. Beneficial and adverse effects of development may occur simultaneously. Through identifying both beneficial and adverse causal linkages, it is possible to develop strategies to minimize adverse effects and to maximize potential benefits at the same time. Many of the effects on social determinants have been discussed above in the analysis for specific health problems. This analysis serves as a summary of the ways in which industrial development in the region may impact factors which underlie the current health status and prevalent health disparities in the North Slope Inupiat community.

For this analysis, we have organized the findings into a table, which shows the determinants of health in the first column, and the potential effects of the proposed action in the second column.

Table 4.3-D.
The Social Determinants of Health and North Slope Oil and Gas Development

Social Determinant:[i]	Potential Effects of Development Alternatives
1. <u>**The Social Gradient:**</u> The 'social gradient' describes the social hierarchy within a society. The "Whitehall Studies" first demonstrated this effect, finding a gradient in mortality from managers to low-ranking staff in British civil service. Other studies since then have confirmed the finding.	*Beneficial:* • Improved educational opportunity and on-the-job training leading to better jobs • Improved economic standard of living *Adverse:* • Perception by residents of "unequal playing field" – adoption of greater society's value structure. • Increased connectivity/exposure to outside 'norms' lead people (especially youth) to awareness of relative disparity • Loss of political control over traditional lands and resources • Devaluing role of subsistence within larger society.
2. <u>**Stress**</u> Studies have developed quantitative measures of stress, and correlated it with higher rates of cardiovascular disease and metabolic syndrome. Attempting to explain this correlation, several studies have suggested that	*Beneficial:* Improved employment and income *Adverse:* • Anxiety and sense of loss over potential and existing impacts to subsistence. • Tension between subsistence pressures and need to work • Exposure to/adoption of norms of "dominant society"

Social Determinant:[i]	Potential Effects of Development Alternatives
catecholamines and cortisol (stress hormones) are responsible.	("acculturation stress") • Time demands of planning and regulatory meetings. • Imposition of a new political process/decision making structure, loss of control over lands leading to sense of disempowerment
3. **Work Environment** The work environment correlates strongly with health status. For example, the incidence of coronary artery disease is up to 2.5 times higher in employees who report low job control than those who report high levels of control. Work pace, variability, and hours have also all been independently associated with health outcomes such as repetitive motion injury.	• Work hours: adequate subsistence leave is an ongoing concern • Job Control: tendency for Native employees to be at lower end of authority because they are less experienced
4. **Employment and Job Security** Unemployment is associated with poor health. However, one study found that people who were 'insecurely employed' had poorer mental health than those who were unemployed. One study in the North Slope showed that employment was inversely associated with measures of overall satisfaction and well-being.	*Beneficial* • Increased employment *Adverse:* • Loss of jobs at conclusion of project • Question of tension between subsistence and work leading to less overall benefit from work for subsistence hunters (Martin 2005)
5. **Education and Early Childhood Environment** Education level correlates with better overall health status. Similarly, a poor early childhood environment (as measured by poor parental support and physical parameters such as poor growth) are associated with poor adult health.	Social pathology is strongly correlated with adverse early childhood conditions. Thus the degree to which project impacts early childhood is related therefore to the degree to which social pathology develops in the community, as well as quality of educational experience, and quality of diet.
6. **Social Support (or "Social Capital") and Social Exclusion** Social support (or 'social capital': correlated with better health) and social exclusion (such as racial discrimination: linked with poor health) are powerful determinants of health. Strong statistical correlations persist after controlling for factors such as	• Subsistence impacts could interrupt sharing networks, which constitutes a significant decrease in social capital • Modern US society has moved toward decreasing social capital (from interdependent communities and extended family/community support toward individuality/nuclear family support). Thus, acculturation which occurs through development would tend to decrease social capital

Social Determinant:[i]	Potential Effects of Development Alternatives
poverty. Authors have observed that social capital is eloquently expressed in subsistence sharing networks.	
7. **Addiction** Problems of addiction – including alcohol, tobacco, and illicit drugs – tend to be more prevalent among more socio-economically disadvantaged groups.	*Beneficial* Increased financial support for prevention/intervention *Adverse* • Importation via oil workers, new access routes to communities
8. **Environmental Quality** Environmental quality is often worse near poor communities. This observation is a manifestation of the political disempowerment of poor and minority groups. Thus, for example, industrial activity is more often located near large industry such as refineries. This observation, and its implications for health status, lead to E.O 12898 on Environmental Justice.	Emissions and small spills contribute to incremental degradation of air and water quality Large oil spills create potentially large increases in risk of contaminant ingestion, contamination of subsistence resources and water supplies
9. **Income Inequality** Not only absolute poverty, but also income inequality within a society has been shown to be associated with health. One of the more dramatic examples comes from Japan, which has the highest life expectancy but also among the highest rates of smoking per capita; among industrialized nations, Japan has the lowest income disparity.	Trend toward increased income disparity within communities, owing to income to shareholders in local village corporation, and income from work limited to certain members of community.
10. **Culture** Cultural integrity protects health. In studies of immigrants, people relocating in a new culture have a tendency to develop the health conditions common to the dominant culture in proportion to the degree of acculturation.	• Trend away from central role of subsistence in community • Transition from subsistence to cash economy • Acculturative influence of 'dominant' culture • Altered relationship with the land in general, and loss of specific regions of importance • New paradigms of decision-making; new locus of control in communities

Thus there would be both beneficial and adverse impacts on health outcomes through the social determinants of health. These impacts would vary with the phases of the project, and with the degree to which the project impacts subsistence, employment, income, and culture. For example, development would result in new employment opportunities and increased median

income, but the post-rehabilitation phase would be a time of marked economic depression and job loss unless new sources of income and employment are found. Similarly, while employment may be viewed as generally positive, in subsistence communities some data suggests that it can also be a source of stress for people who are under pressure as subsistence providers as well (Martin, 2005). Acculturation occurs through exposure to norms, values, and practices of another culture; projects which involve large numbers of employees entering a community must be considered a source of acculturation stress. The loss of control over, and impending development of, lands of tremendous traditional and practical importance would likely lead to significant stress, and may also be viewed as creating an adverse social gradient, in which residents have less control over their lands and way of life than they have at present. Lifestyle changes fostered by the economic and social influences of the project may lead to the gradual replacement of subsistence by modern foods, and a trend away from the sharing networks which are a source of high social capital toward a more "westernized" nuclear family structure.

Effects of Abandonment and Rehabilitation

The North Slope economy and citizens have become heavily dependent on revenue from oil and gas development. After the termination of development, revenues to the NSB and local Native corporations could decline considerably. The rehabilitation work available may lead to a transient increase in employment, but this could be followed by a period of significantly declining employment, both because of decreasing NSB revenues and because of loss of direct jobs. As noted previously, economic depression and job loss are strongly associated with social pathology, which would likely increase during this period. It is possible that subsistence resources could become more readily accessible after a period of adjustment, although this must be considered highly speculative in view of the baseline of rapid environmental change. If this occurred, it would help offset effect of decreasing capital available for purchase and repair of hunting equipment and fuel purchase. The decline of these revenues is likely to have profound effects. It is not clear whether people will be able to resume their pre-development way of life, whether subsistence resources will have become too depleted or contaminated from oil and gas development, or how people will continue to support a lifestyle which depends heavily on modern technology. Viewed from the perspective of the social determinants, this period will have large implications for health given the large-scale economic and employment transition anticipated.

Effects of Oil Spills

Oil spills can affect human health in a number of ways. Direct contamination can produce toxicological effects; rashes and respiratory symptoms have been documented after acute exposure (Lyons, Temple et al. 1999). Longer-term effects from contamination of subsistence resources by organic compounds such as polycyclic aromatic hydrocarbons could lead to chronic exposure-related illnesses such as cancer, birth defects, miscarriages, and endocrine disruption (AMAP 2002; San Sebastian, Armstrong et al. 2001, 2002). Social and psychological effects of large oil spills are also a significant source of morbidity. Residents in the vicinity of an oil spill have been shown to have higher rates of anxiety disorder and post-traumatic stress disorder (Palinkas, Petterson et al 1993; Lyons, Temple et al 1993). A very large oil spill could result in a significant decrease in subsistence activity, as was seen after the Exxon Valdez oil spill. In turn, this would to marked changes in social organization, decreased social capital, decreased consumption of subsistence foods, and an attendant increased risk of social pathology, injury, and diabetes and metabolic disorders (re. social capital and EVOS: Ritchie and Gill 2004). The magnitude of these problems would depend largely on the extent of the spill, and the degree to which it impacted local subsistence resources. Under Alternative A, the risk of a very large spill

(greater than or equal to 120,000 barrels, such as from a well blowout) is considered very low, while two large spills (greater than or equal to 500 barrels but less than 120,000 barrels) are expected.

4.3.19.3 Effectiveness of Stipulations

Under Alternative A, lease stipulations identified in the 1998 Northeast IAP/EIS ROD would remain in effect. These lease stipulations were the result of 18 months of intensive consultation among the communities near the planning area and the local, state, and Federal agencies with management interests in NPR-A lands and waters. The 79 lease stipulations provide protections for subsistence resources, cabins, camps, and river corridors, as well as the system of negotiating conflicts between leaseholders, and subsistence users. Lease stipulations relevant to sociocultural effects are also described in **section 4.3.12, *Subsistence***.

When considering the effectiveness of stipulations in mitigating public health effects, it must be recognized that because the Inupiat people continue to value this land deeply as a foundation of well-being and culture, any stipulation which contributes to minimizing the environmental impacts of development in the region can be seen as contributing positively toward overall well-being. Under Alternative A, Stipulations 1-5 and 38 address contaminants, Stipulations 6-14 address prevention and response to spills; and Stipulations 14-17 address fuel storage. In as much as these Stipulations will reduce the potential for environmental contamination by substances which could lead to health problems such as cancer, and to contamination of subsistence resources which could lead to avoidance, they would be effective in preventing an array of health problems. Stipulations 19-20, 30, 39, and 40-43 would help protect fish habitat; Stipulations 25, 29, 31-37, and 48-49 are intended to protect caribou calving and migration. To the extent that these Stipulations prevent impacts to subsistence resources, they would effectively lessen nutritionally and socially-mediated public health problems. Stipulations 47 and Lease Stipulations 23 and 47 would help prevent disruption of family campsites and camps by limiting seismic activity and permanent facilities nearby. These Stipulations would help preserve the cultural value of the region for families, and thereby provide moderately effective mitigation. Stipulation 62 would also provide effective mitigation in this regard, through establishing additional protection and community consultation for development in areas which are particularly sensitive ecosystems and important subsistence areas. Stipulation 63 establishes a cultural orientation program for workers. If this orientation is effective at changing employees' attitudes and behaviors, it would be effective at helping to prevent acculturation stress and social pathology. Overall, however, in the face of expanding development, particularly with the development of important subsistence areas, it is likely that there would be substantial unmitigated impacts to health and the social determinants of health.

The implementation of the 1998 prescriptive lease stipulations has been underway for a relatively short period of time, limiting an empirical assessment of their effectiveness. However, the 1998 lease stipulations were developed through extensive consultation with local communities, and local residents are generally less familiar with the new approach to mitigation measures, relying on performance-based lease stipulations and ROPs rather than prescriptive lease stipulations.

4.3.19.4 Conclusion

Under Alternative A, there could be substantial impacts to human health. These impacts would occur primarily through restriction in subsistence; influx of large numbers of outside workers; new access routes to the community; sociocultural and economic change; altered employment;

and emissions. Diabetes, hypertension, and related metabolic disorders would be expected to increase as subsistence is curtailed or as sociocultural changes lead to alterations in dietary patterns; these health outcomes would be mitigated by measures which protect subsistence, but as displacement of fish, caribou, and potentially whales are still anticipated, mitigation would not be entirely effective. Hunger and food insecurity could increase if there are substantial disruptions to subsistence harvests. Cancer, lung disease, endocrine disruption, and neurodevelopmental delay are related to contaminants common to oil and gas development; there is limited data available to allow determination of the likely concentrations or distribution of these emissions. Nevertheless, the existing data, though incomplete, are reassuring as to present levels of contaminants. Social pathology could result from the economic changes anticipated; from increasing access to drugs and alcohol; and from stress and maladaptive coping given the impacts to wider regions of important traditional use areas. While measures such as Stipulation 63, which mandates a cultural orientation program, and stipulations that protect subsistence resources would be partially effective, they could not offset the large-scale socio-economic impacts discussed in the preceding sociocultural and public health sections.

4.3.19.5 Potential New Mitigation Measures

1) Health Advisory Board

<u>**Potential Mitigation Measure (New Stipulation)**</u>
Lessees in proposals for permanent oil and gas facilities within the planning area shall provide a Health Advisory Board, should one be formed by the NSB or other North Slope-wide representative entity, or any other source of recognized public health expertise identified by the AO, an appropriate analysis of potential public health impacts of the proposal and means proposed to mitigate these impacts as part of their development plan. (BLM would also analyze public health impacts and potential mitigation measures in any NEPA analysis examining such a proposal).

Potential Benefits and Residual/Unavoidable Impacts

This measure would establish a basic framework to allow the evaluation and monitoring of public health concerns associated with development in the planning area. Because it will facilitate efforts by BLM, industry, ADEC, and public health agencies, this measure is likely to be very effective in allowing the recognition of potential public health problems. The efficacy of this measure in preventing adverse public health outcomes would depend on the degree to which this information is utilized by planners, public health agencies, and industry to inform development decisions and public health interventions. Because of the expansion of development into a region of key cultural and subsistence value, it is likely that there would be residual subsistence-related health effects (including effects on metabolic disorders, food security, social pathology, injuries, and, potentially, contaminant-related health concerns.)

2) Subsistence

<u>**Potential Mitigation Measure (New Stipulation)**</u>
Initial Study: Before authorization of construction of permanent facilities, the lessee shall design and fund studies, in consultation with affected communities, to: a.) determine the historic and current use of resources dependent on proposed development area, and b.) the significance of the proposed development area to caribou and any other species important to subsistence food intake. The study is to serve as a basis for monitoring impacts to subsistence food harvest that may be caused by the lessee's development. The lessee shall submit study

proposals to the NSB for review and comment, including the adequacy of the area and timescale of the studies. The lessee is also advised to consult with the NSSI or relevant constituent members to reduce potential duplication of effort. Studies should be designed to address the potential confounding factors such as reporting inaccuracies common to harvest studies. Lessees are encouraged to cooperate or contract with local entities such as the NSB or ICAS to facilitate accuracy of the data collected. A proposed study design along with any comments received from the NSB and other state and Federal agencies with relevant expertise on the study proposals shall be submitted to the AO. The design of the studies must meet the approval of the AO. The studies should cover a sufficient time such that, in conjunction with other studies, they provide reliable information about the importance of the proposed development area to subsistence harvests (generally will be presumed to be approximately 3 years in length). The results of the studies shall be submitted as part of permit applications and be used in the development NEPA analysis, including in proposing alternatives and mitigation. The AO may waive this requirement if, after considering comments by the NSB and relevant state and Federal agencies, the AO determines that either (1) the research duplicates other efforts, (2) the research will not benefit the communities that depend on the region for subsistence, or (3) the research will cause an undue burden on the community(ies) that depend on the region for subsistence.

Continued Subsistence Monitoring: During construction, operation, and abandonment, the lessee shall, subject to the same waiver provisions applicable to the initial study, conduct studies of current subsistence use of the development area, the harvest of caribou and other subsistence foods from the area, the trends in such use and harvests, and any impacts to caribou and other species important to subsistence food intake that would affect their availability for subsistence users. The AO may require/authorize changes in the design of the studies throughout the period, or terminate or suspend such studies if results warrant.

Mitigation of Subsistence Impacts: If between the commencement of construction and approval of completion of abandonment measures, the AO determines that the lessee's actions are causing or have caused a reduction in subsistence harvests, the AO may require changes in construction, operations, or abandonment activities. These changes may include restrictions on intensity and timing of activities, including temporary cessation of activities, and any and all other practicable measures that could reduce impacts. The restrictions, however, may not so restrict the lessee's activities to preclude exercise of the rights of the lease. Continued subsistence monitoring will be used to evaluate the effectiveness of these mitigations.

Potential Benefits and Residual/Unavoidable Impacts

Monitoring of subsistence impacts would facilitate early recognition of project-related impacts to harvest levels, and allow institution of measures to prevent further decline. This would help protect subsistence resources, such as caribou and fish, and/or subsistence users' access to these resources and help protect communities from food insecurity, hunger, and diabetes and metabolic syndromes; it would also help to prevent social pathology through ensuring the continued viability of subsistence as a way of life. Even with the inclusion of this measure, some displacement of subsistence animals and hunters may occur, and it may therefore not be possible to entirely prevent impacts to subsistence harvest levels.

3) Public Health Monitoring

Potential Mitigation Measure (New Stipulation)
In consultation with appropriate experts, including the NSB, lessee will fund the design and implementation of a public health monitoring study. The study will involve selection of a limited set of public health indicators, chosen for their ability to detect changes in health and social conditions, and routine monitoring of these indicators. The study shall include a minimum of three years of pre-development data and continue over the life of the development. Results will be reported semiannually to the AO, who, with appropriate consultation with public health experts or the HAB (once established), will utilize this information to inform performance-based management decisions involving activities within the planning area.

Potential Benefits and Residual/Unavoidable Impacts

Monitoring public health indicators would allow the detection of health status changes over the course of development in the planning area, and thus aid efforts to prevent or respond to public health problems related to development activities. The efficacy of the measure would depend on the degree to which the monitoring effort results in health-focused management decisions. Many of the potential public health problems discussed above relate to impacts to other resources (such as subsistence and air quality); the monitoring of health indicators may thus inform BLM's management approach to these resources. In some cases, however, BLM may not have direct authority to render management decisions strictly on the basis of health concerns, in which case there may still be unavoidable public health effects despite an effective monitoring strategy.

4) Control of Contaminant-related Health Risk

Subsistence Food and Habitat monitoring

Potential Mitigation Measure (New Stipulation)
Initial Study: Before authorization of construction of permanent facilities, the lessee shall design and fund a baseline study to determine the level of contaminants, such as benzene, toluene, ethyl benzene, xylene, and PCBs, commonly associated with oil production, in subsistence food species and their habitat. The study should examine species and habitat potentially impacted by contaminants by the lessee's proposed development. The lessee shall consult with relevant Federal, state, and NSB agencies. A proposed study design shall be submitted to the AO. The AO may consult with appropriate Federal and State agencies with regulatory authority over the release of such contaminants prior to approving the study design. The design of the study must meet the approval of the AO. The study should cover a sufficient time such that, in conjunction with other studies, they provide reliable information about the existing level of contaminants. The results of the studies shall be submitted as part of permit applications and be used in the development EIS, including in proposing alternatives and mitigation.

Continued Contaminant Monitoring: During construction, operation, and abandonment, the lessee shall conduct studies designed to detect any contamination of subsistence foods by the oil and gas development. These studies shall be subject to approval by the AO. The AO may require/authorize changes in the design of the studies throughout the period, or terminate or suspend such studies if results warrant.

Mitigation of Contaminant Impacts on Subsistence: If between the commencement of construction and approval of completion of abandonment measures, the AO determines that the lessee's actions are causing or have caused levels of contaminants that pose a substantial health risk to subsistence resource users, the AO may require changes in construction, operations, or abandonment activities. The AO will consult with appropriate Federal and State agencies with regulatory authority over the release of such contaminants. BLM may defer to these other agencies, but may independently require mitigative actions. Continued contaminant monitoring will be used to evaluate the effectiveness of these mitigations.

Potential Benefits and Residual/Unavoidable Impacts

The measure could have several beneficial effects on Public Health. First, it would help ensure that the human populations that rely on the planning area would not be exposed to harmful levels of oil development-associated contaminants, which would help protect the communities against a range of contaminant-associated disorders (such as cancers, birth defects, neuro-developmental delay, and endocrine disorders). Second, it may help reassure communities of the continued safety of subsistence resources, thereby fostering the continued viability of the subsistence diet and way of life, and helping to prevent food insecurity, diabetes and metabolic syndromes, and social pathology. The measure would be effective in preventing exposure to contaminants associated with local development. But it would not, however, be expected to eliminate contaminant-related health risk, nor the perception of risk. Contaminants occur in subsistence foods from world-wide sources, and this problem would be expected to continue regardless of the controls on local development. In addition, this measure could reduce any potential impacts to subsistence resources from contaminants.

5) Air Quality Monitoring and Management

Potential Mitigation Measure (New Stipulation)

Prior to initiation of a NEPA analysis for an application to develop a CPF, production pad/well, airstrip, road, gas compressor station, or other potential air pollutant emission source, the lessee shall identify background air quality and meteorology data to be used in predicting potential future air quality conditions resulting from the proposed action and other Reasonably Foreseeable Future Actions. If these data can not be estimated, then in the case of a proposed CPF or other facility with potentially large impacts on air quality, one year of on-site monitoring (subject to BLM review and approval) will be conducted to obtain such data. In addition, the lessee shall prepare (and submit for BLM approval) a complete list of reasonably foreseeable air pollutant emissions, including, but not limited to criteria and hazardous air pollutants. Depending on the levels of anticipated emissions, and potential for cumulative air quality impacts, the BLM may require complete direct/indirect/cumulative air quality modeling for the operation phase of the proposed facility. The modeling shall at a minimum compare predicted impacts to all applicable local, state, and Federal air quality standards and increments, as well as other scientifically defensible significance thresholds (such as impacts to Air Quality Related Values, incremental cancer risks, etc.). Depending on the significance of the predicted impacts, a lessee proposing a CPF or other facility with potentially large impacts on air quality may be required to monitor air pollutant emissions and/or air quality impacts for at least one year of operation. Depending upon the initial monitoring results, the AO may also require additional monitoring. If monitoring indicates impacts would cause unnecessary or undue degradation of the lands or fail to protect health (either directly or through use of subsistence resources), the AO could require changes in the lessee's activities at any time to reduce such emissions, such as, but not limited to, use of cleaner-burning fuels or low-emission compressors.

Potential Benefits and Residual/Unavoidable Impacts

The measure would protect communities against health problems related to airborne pollutants through ensuring the adequacy of data used to evaluate the impact of activities in the planning area on local air quality, and through establishing additional regulatory measures if substantial degradation of air quality is found to occur. The efficacy of this measure, and the residual air quality-related health effects would depend on the accuracy of modeling utilized, and on the efficacy of any additional regulatory requirements for emissions controls.

6) Public Safety and Infectious Disease

Add the following requirements to Stipulation 63:
Include a module designed to ensure strict compliance with local and corporate drug and alcohol policies. This module should be offered to the NSB Health Department for review and comment.

Include a module developed to train employees on how to prevent transmission of communicable diseases, including sexually transmitted diseases, to the local communities. This module should be offered to the NSB Health Department for review and comment.

Potential Benefits and Residual/Unavoidable Impacts

To the extent that orientation programs result in meaningful behavior changes, the addition of modules addressing communicable diseases and drug and alcohol importation to ROP I-1 may be helpful in preventing communicable disease and drug and alcohol abuse. It is likely that despite efforts at education, there would be a continued residual risk of isolated events of illicit drug or alcohol importation and infectious disease transmission.

7) Oil Spills

Potential Mitigation Measure (New Stipulation)
In the case of a spill of a size and under circumstances that indicate a potential for substantial impacts to subsistence resources, and upon the direction of the AO, lessee shall fund the institution of a scientific review panel to advise the AO regarding monitoring of the effects of the spill on populations of subsistence resources, harvesting of subsistence resources, and contaminant levels in subsistence resources. The AO will appoint members to the scientific review panel with expertise in biological and social sciences as well as in public health. The AO will determine what monitoring is to be required and how long such monitoring shall continue. The lessee shall fund all monitoring. The AO will establish requirements in consultation with other Federal, state, and local authorities with authority to require post-spill monitoring and remedial actions.

Potential Benefits and Residual/Unavoidable Impacts

In the case of a large oil spill, the creation or a formal process for monitoring and mitigating public health effects would greatly facilitate efforts to prevent harm to the local communities. In addition, remedial actions may benefit surface resources, including, but not limited to vegetation, water, fish, terrestrial mammals, and birds. However, even with the most rigorous monitoring and remedial actions, a large oil spill might have unmitigatable adverse effects on community health and well-being and on surface resources.

Potential Effects on Oil and Gas Development

The expense of the above potential mitigation measures varies widely, from insignificant to potentially millions of dollars. To the extent that the potential mitigation measures would add expense to oil and gas activities, they could discourage leasing, exploration, and development of oil and gas.

4.4 ALTERNATIVE B

4.4.1 Air Quality

4.4.1.1 Activities Not Associated With Oil and Gas Exploration and Development

Air quality impacts associated with these activities are the same as those associated with Alternative A, discussed in **section 4.3.1.1**.

4.4.1.2 Oil and Gas Exploration and Development Activities

The Air Pollutant Emission Sources, Effects of Air Pollution, and Native Views on Air Emissions are the same as those associated with Alternative A, discussed in **section 4.3.1.2**.

Air Pollutant Emissions

Air pollutant emission estimates for Alternative B were based on the following information sources:

1) Helicopter emissions were based on the Federal Aviation Administration's Emissions and Dispersion Modeling System (EDMS version 4.1) for a Bell 206 (Edwards, 2007);
2) Emission estimates developed for the Alpine Satellite Development Plan (USDOI BLM, 2004c) for satellite well pad/access road construction, fixed wing aircraft flights, drilling rigs, and specific production equipment (satellite heaters, field generator, and a CPF turbine); and
3) Actual 2006 air pollutant emissions from the ConocoPhillips Alpine Production Facility (Poteet, 2007).

These emission factors were adjusted for the following assumed activities under Alternative B:

1) Helicopters: 5,000 one-hour flights per year;
2) Exploration/Delineation: up to 144 fixed wing flights per year, 97 exploration wells and 73 delineation wells, 6 drill rigs;
3) Construction: 3,393 fixed wing flights per year, 2 drill rigs, 3,716 acres of land disturbance; and
4) Production: 672 fixed wing flights per year, 25 satellite well pads, 6 Central Production Facilities, and 74 MMbbl peak annual oil production.

Based on these emission factors and anticipated activity, the maximum annual emissions (in tons per year) by activity phase are presented in Table 4.4-A.

Development and production activities can also produce fugitive dust emissions (primarily as PM_{10}). Fugitive dust occurs primarily during the summer months due to driving on unpaved roads. Vehicles can also track out fine material from gravel mining operations in the winter and summer months. Potential control measures include limiting vehicle speeds, and treating problematic road sections with surfactants or water.

Well closure, abandonment and rehabilitation activities would emit air pollutants similarly to those during development (construction), since similar vehicles and other emission sources would be used. Because closure activity would not occur at a single location for any substantial length of time, the impact of air emissions at any single location would be minor and short term. Impacts could be minimized by leaving gravel on-site, limiting the amount of transport. Once reclamation is complete, production facilities would no longer impact North Slope air quality.

In comparison, a site-specific air quality impact analysis was conducted for the off-shore Liberty Project (USDOI MMS, 2002), which would be somewhat smaller than a typical field that could be developed in the planning area, which demonstrated ambient air quality levels would be close to, but within applicable PSD Class II increments. The combined facility concentrations plus background were predicted to remain well within the ambient air-quality standards (between 2 and 30% of the standards). Because Alternative B facilities would have similar air emissions as those predicted for the Liberty Project, it is likely potential satellite well pads and central production facilities would have similar air quality impacts. However, the accuracy of determinations of specific air pollutant emissions and potential impacts is necessarily limited at this stage, given that particular site-specific development activities are not yet able to be predicted.

Since CO_2 has not been regulated as an air pollutant, potential CO^2 emissions were not quantified for Alternative B. However, assuming an average 98% combustion efficiency, the CO emissions reported in Table 4.4-A may be multiplied by 80 to estimate equivalent CO_2 emissions (a maximum of 23 x 10^4 tons per year). However, when compared to estimated worldwide emissions of CO_2 (nearly 28 x 10^9 tons per year), Alternative B would contribute minuscule amounts of CO_2 emissions to global levels.

4.4.1.3 Effectiveness of Stipulations and Required Operating Procedures

No air quality lease stipulations or ROPs were included for Alternative B. Potential air quality impacts from site-specific development activities would be limited based on air quality permits issued by the ADEC and EPA, including applicable control technologies.

4.4.1.4 Conclusion

Air quality impacts from Alternative B are likely to remain below applicable ambient air quality standards and increments, therefore no significant impact to air quality is expected. Air pollutant emissions associated with Alternative B are approximately 17 to 19% greater than Alternative A, but less than Alternatives C and D. Each new exploration or development activity, or production area, would result in an additional air pollutant emissions. However, the accuracy of determinations of specific air pollutant emissions and potential impacts is necessarily limited at this stage, given that particular site-specific development activities are not yet able to be predicted. As exploration and development activities cease, or production sites are shut-in, there would be a corresponding decrease in air emissions.

Table 4.4-A. Alternative B Air Pollutant Emissions from Surface Activities (tons per year)

Activity Phase	Carbon Monoxide	Nitrogen Oxides	Particulate Matter [1]	Sulfur Dioxide	Volatile Organic Compounds
Helicopters	10	1	1	<1	<1
Exploration/ Delineation	36	160	8	18	<1
Construction	89	328	23	26	29
Production	2,711	14,134	335	457	325
Total	2,845	14,623	366	501	354

Source: Archer, 2007

[1] Combustion sources primarily emit $PM_{2.5}$ while land disturbance primarily emits PM_{10}.

4.4.2 Paleontological Resources

4.4.2.1 Activities Not Associated With Oil and Gas Exploration and Development

Under Alternative B, the types of non-oil and gas activities would be the same as those described for Alternative A; however, there would be likely be an increase in the level of aircraft and survey activity associated with environmental studies and monitoring. Despite increased activity, the impact to paleontological resources, which are deeply buried, would still be minor.

4.4.2.2 Oil and Gas Exploration and Development Activities

Under Alternative B, the level of seismic activity is expected to increase beyond that of Alternative A because an additional 387,000 acres would be available for leasing, and these additional acres would be in an area with high oil and gas potential. While the types of impacts to paleontological resources would remain the same, the increased level of seismic activity would increase the potential for impacts to occur. Any impacts associated with the increased seismic activity are expected to be minor.

Significant paleontological resources (primarily vertebrate fossils) are not ubiquitous in the planning area as these resources are exposed primarily through erosion (stream cuts, bluff faces, etc.) elsewhere they are usually deeply buried. As a result, the location of exposed material can be to some degree predicted and therefore avoided while the remainder is protected by its depth of burial.

Effects of Disturbances

Under Alternative B, the level of activity in the planning area would increase. However, because most of the activity would occur during the winter months, the potential for impacts to paleontological resources is extremely minor. The likelihood of impacting surface paleontological material also is low due to their isolated and rare occurrence.

The drilling of exploration wells and delineation wells would typically occur during winter. It is expected that no more than six wells would be drilled at one time. Drill pads, camp pads, roads, and airstrips made of ice and snow would be used, but permanent pads, roads, or airstrips could also be constructed; therefore, ground disturbance could occur and buried paleontological material could be impacted. The other substantial subsurface disturbance that would occur as a result of the actual drilling would be the making of the drill hole itself. Were scientifically important paleontological material present at the site of the borehole, these resources could be impacted by the drilling process. However, the likelihood of such an occurrence is minor.

Surface disturbance from development could impact as much as 3716 acres, but there would be limited subsurface impacts associated with these activities. The primary impact to paleontological resources would result from the excavation of material for construction of the permanent facilities. Extraction of the terrestrial materials could impact paleontological resources. Pleistocene vertebrate fossils are commonly recovered during gravel-mining operations on the North Slope. It is anticipated that a pipeline would not have associated all-weather roads or pads and would be constructed during the winter months from ice roads and/or pads. Therefore, the only substantial impact resulting from pipeline construction would be associated with the placement of VSMs. Depending on the depth at which the VSMs were set it is possible, though highly unlikely, that paleontological resources would be impacted. Overall, ground disturbance from development would have a minor impact on paleontological resources.

It is unlikely that paleontological resources would be impacted by abandonment activities, as these areas would have been previously disturbed by construction and development activities.

Effects of Spills

Under Alternative B, the effects of spills on paleontological resources would be essentially the same as discussed under Alternative A. If present, surface paleontological material could be impacted; however since the occurrence of paleontological remains is rare, the probability of an impact is very low.

Commercial Gas Development

The types of impacts on paleontological resources that natural gas development and production would cause would be the same as those caused by oil development described above, except that there would be no crude-oil spills and if a gas pipeline is buried—the likely method—there would be additional acreage disturbed with increased potential for disturbance or destruction of paleontological resources. As with Alternative A, it is anticipated that burying the pipeline would result in digging up approximately 162 miles of four feet wide and five feet deep trench (approximately 80 acres) and potential surface disturbance of 210 acres in areas adjacent to the trench from potential disturbance from machinery or placement of backfill. The risk to paleontological resources would be reduced dramatically if gas pipelines are put on VSMs. Additional disturbance would occur from disturbance associated with building a 10- to 20-acre compressor pad.

4.4.2.3 Effectiveness of Stipulations and Required Operating Procedures

Required Operation Procedure C-2(a,b,c,e) would provide protection from seismic and overland move activities that could potentially disturb the vegetative mat and impact paleontological resources that are near the surface. Additionally, ROPs A-3 and A-4(a, b, c, d) would help to prevent large fuel or crude oil spills, and consequently reduce the small potential for impacts to paleontological resources from spill cleanup. Within the planning area, paleontological resources are most diverse and abundant along the Colville and Ikpikpuk rivers. Lease Stipulation K-1(a, b) would prohibit the construction of permanent oil and gas facilities within and adjacent to waterbodies, which would protect exposed paleontological resources along the banks of the Colville and Ikpikpuk rivers. Lease Stipulation E-13 would protect previously unknown paleontological resources by requiring a paleontological survey prior to any ground-disturbing activity. If paleontological material were discovered, all operations would be suspended until written authorization to proceed is issued by the appropriate authority. These ROPs and lease stipulations would be highly effective in protecting known and previously unknown paleontological resources and preserving their research potential and ensuring that impacts to paleontological resources would be minor.

4.4.2.4 Conclusion

The types of impacts to paleontological resources from management activities other than oil and gas exploration and development would be similar in nature to what was described for Alternative A. The potential impacts to paleontological resources from oil and gas exploration and development are about the same as Alternative A, based on area of surface disturbance. Impacts could be greater if exploration and development occurred in an area with abundant paleontological resources. However, the ROPs and lease stipulations proposed to protect paleontological resources under this alternative would be highly effective.

4.4.3 Soil Resources

4.4.3.1 Activities Not Associated With Oil and Gas Exploration and Development

Various types of activities not related to oil and gas leasing and development, including private or commercial air traffic, summer research camps, use of off-highway vehicles (OHVs), recreational camps, paleontological and archaeological excavations, and overland moves could affect soil resources in the planning area under Alternative B.

Under Alternative B, impacts associated with non-oil and gas activities would be similar to those described under Alternative A. These activities could occur throughout the planning area and would be little affected by the increased availability of land for oil and gas leasing.

4.4.3.2 Oil and Gas Exploration and Development Activities

The following analysis is based on **section 4.2.1.2, *Oil and Gas Exploration and Development Activities*.** See that section for a discussion of estimates and assumptions for development as well as a description of how estimated areas of disturbance were calculated for each alternative.

During oil and gas exploration and development, various activities could cause impacts to soil resources in the planning area. These activities include seismic activities; construction and use of gravel pads, gravel roads, gravel airstrips, and pipelines; excavation of material sites; construction of ice roads and ice pads; and summer tundra travel. Impacts could also occur from oil spills and from removal of gravel pads and gravel roads during rehabilitation. These activities would impact soil productivity and could alter the moisture regime of tundra near the structure by changing natural drainage patterns and areas where snow accumulates. Types of impacts to soil resources for Alternative B would be similar to those described for Alternative A. Differences in the magnitude and area of impacts for Alternative B are described below.

Effects of Disturbances

Seismic Surveys. Effects to soils from seismic surveys would be the same as for Alternative A. Under all of the alternatives, it is projected that three 2-D and two 3-D surveys would be done to fill in gaps in existing surveys.

Exploration. Under Alternative B, impacts to soil from activities associated with oil and gas exploration would be somewhat greater than those described for the Alternative A. It is anticipated that under Alternative B there would be a greater number of exploration and delineation wells drilled, which would result in greater impacts to soil resulting from the construction of both multi and single year ice pads (500 feet by 500 feet; 6 acres). Under Alternative B, it is assumed 97 exploration wells and 73 delineation wells, or a total of 170 wells, would be drilled from ice pads in the planning area. Impacts to soils would occur on approximately 1,020 acres (170 ice pads x 6 acres/ice pad) over a period of about 25 years (Table 4.2-G).

Ice road construction, probably up to 50 miles per year impacting approximately 212 acres/year, could also be greater under Alternative B in terms of total miles constructed. For Alternative B, it is estimated that a total of 6,200 miles of ice road would be constructed during the life of the plan impacting approximately 19,000 acres (Table 4.2-G). In addition, approximately 30 miles of ice runway would be constructed impacting approximately 330 acres.

The construction of well cellars during exploration requires digging a hole that would impact approximately 16 square feet (0.0004 acres) of ground for each well. Total area disturbed by digging well cellars under Alternative B would be approximately 0.06 acres (170 wells x 0.0004 acres per well). Thermokarst associated with the disruption of the thermal regime in the surrounding soil could occur around the well cellars and cause long-term disturbance to these small areas.

Placement of Gravel Fill. Types of impacts to soils from placement of gravel fill would be similar to those in Alternative A. Construction of CPFs and associated satellite pads, roads, staging areas, and airstrips would result in the loss of soil productivity in the areas of gravel placement. Under this alternative, it is estimated that 6 fields would be developed (one more

than Alternative A), resulting in a total of approximately 3,100 acres of soil productivity lost by gravel placement (Table 4.2-G).

Construction of CPFs and associated gravel pads, roads, staging areas, and airstrips could alter the moisture regime of tundra near the structure by changing natural drainage patterns and areas where snow accumulates. Snowdrifts caused by gravel structures would increase the wintertime soil surface temperature and increase thaw depth in soils near the structures. These impacts would be exacerbated by dust deposition and by the formation of impoundments. These factors could combine to warm the soil, deepen thaw, and cause thermokarst adjacent to roads and other gravel structures (NRC 2003). In flat, thaw-lake plains on the North Slope, gravel construction can be anticipated to result in upslope water impoundment and thermokarst erosion equivalent to the area directly covered by gravel (Walker et. al. 1987). In this analysis, approximately 3,050 acres could be covered by gravel under Alternative B. Therefore, the total area of soils impacted by gravel fill under Alternative B is estimated at approximately 6,100 (2 x 3,050) acres. This is approximately 700 acres more than under Alternative A.

Material Sites. Gravel required for development in the planning area could be mined from existing sites east of the planning area or could be extracted from new sites developed within the planning area. Investigations to identify gravel sources in the planning area have not been conducted, but presumably would be initiated if discoveries of recoverable oil or gas were made. Under Alternative B, it is possible that 13 gravel mine sites would be necessary, resulting in a total of approximately 650 acres impacted, depending on the actual number of sites required. Excavation of the gravel mine and stockpiling of overburden would remove soil and impact soil productivity at these sites. In this analysis, the likelihood of new gravel sites within the planning area would be greater under Alternative B than under Alternative A.

Pipelines. Under Alternative B, given the potentially greater number of fields developed, impacts from pipeline construction would be greater than those described for Alternative A. Pipelines on the North Slope are typically built on VSMs with a diameter of 12 inches and a spacing of 150 VSMs/mile. Under Alternative B, 412 miles of pipeline would be required resulting in short term disturbance to soils of approximately 1,251 acres and a long term impact at VSM sites of approximately 2 acres (Table 4.2-G).

The extent of impacts associated with buried pipeline could also be greater under Alternative B given the potentially greater number of fields developed. In areas where pipelines were buried, construction of a trench would impact soil and temporary storage of overburden in adjacent areas would alter soil where temporary storage of the overburden occurred. The zone of impact would be approximately 12 feet wide for the length of the buried segment, and the total area of impact would be 1.5 acres per pipeline mile. Because pipeline burial under tundra has been the exception on the North Slope rather than the norm, it is expected that this activity would disturb only a small amount of area in the planning area.

Effects of Oil and Gas Development on Permafrost

Types of impacts to permafrost from oil and gas development would be the same as those described in Alternative A. Under alternative B, more surface disturbance is expected from oil and gas activities as compared to Alternative A (Table 4.2-G). Therefore, there would be more area of permafrost potentially affected.

Abandonment and Rehabilitation

Types of impacts from abandonment and rehabilitation would be the same as those described in Alternative A. Under alternative B, it is expected that more structures would be constructed for oil and gas activities as compared to Alternative A (Table 4.2-G). Therefore, the amount of rehabilitation required, and impacts to soils from abandonment and rehabilitation, would be greater than under Alternative A.

Effects of Spills

Effects of spills on soils would be similar to those in Alternative A. Under Alternative B, impacts to soils from oil spills could be somewhat larger than in Alternative A as the estimated number of large and small spills is slightly greater (see **section 4.2.2, *Oil Spills***).

Summer Tundra Travel

Under Alternatives B, C, and D some summer tundra travel would be permitted under specific circumstances. Although travel off of gravel pads is easiest in winter and generally environmentally preferable at that time, some vehicle travel off of pads does occur in North Slope oil fields during the summer to accomplish specific tasks. The State of Alaska has approved some low-ground-pressure vehicles for summer tundra travel after July 15. Similar summer tundra travel may be anticipated to be part of oil production in Northeast NPR-A.

Summer vehicle tundra travel is commonly associated with spill prevention and preparedness measures required in spill prevention plans. Each summer season, low-ground-pressure vehicles might be used to transport and place booms across streams downstream from pipelines. These booms are left in place through the summer to capture any oil that might spill from a pipeline and then would be retrieved, again probably using low-ground-pressure vehicles, before freeze-up. Pipeline inspections may also entail summer vehicle travel on the tundra. Finally, periodically spill response training may occur along and downstream from pipelines in summer.

As a rule, summer tundra travel would not be permitted under Alternative A. Therefore, given the potentially greater number of fields developed and allowance of summer tundra travel under certain circumstances, impacts from summer tundra travel under Alternative B could be greater than in Alternative A. Short-term, minor impacts to soils are expected from limited summer tundra travel using low ground pressure vehicles. However, ROP L-1 is designed to regulate and monitor summer travel and minimize impacts to soils and vegetation. Summer travel would only be permitted on a case-by-case basis if the applicant can demonstrate that the proposed use would have no more than minimal impacts to soils and vegetation.

Commercial Gas Development

The types of impacts on soils that natural gas development and production would cause under Alternative B would be the same as those caused by oil development described above, except that there would be no crude-oil spills. Because the length of buried gas pipeline and the single stand-alone compressor station would be the same as projected for Alternative A, it is anticipated that gas development would cause similar impacts as Alternative A.

4.4.3.3 Effectiveness of Stipulations and Required Operating Procedures

To protect soils in the planning area, the approval of most proposals for summer operations are limited. Because of the fragile nature of thawed tundra during the summer, permit sites are restricted to durable areas such as gravel bars, beaches, or existing gravel pads. Vehicles allowed for use in overland moves would exert low ground pressure and be permitted to travel only over snow-covered ground frozen to a sufficient depth to minimize soil and vegetation impacts. Many of the lease stipulations and ROPs under Alternative B directly or indirectly limit potential impacts to soils in the planning area. Lease stipulations and ROPs developed to protect soil under Alternative B would provide similar protection to soils resources as the stipulations developed for Alternative A.

Many of the lease stipulations and ROPs under Alternative B would directly or indirectly limit potential impacts to soils in the planning area. Required Operating Procedures A-2 through A-7 relate to waste prevention, handling, disposal, and spills. These ROPs would be effective in ensuring that waste materials associated with exploration and development activities were properly disposed of, and helping to prevent impacts to vegetation from spills and mishandling of materials. They would also provide for rapid cleanup of spills, which would decrease the likelihood of impacts to soils from spills. Required Operating Procedures C-2, C-3, and C-4 would be highly effective in limiting impacts to soils associated with overland moves and seismic work. Required Operating Procedure L-1 would require applicants to demonstrate that summer tundra travel would have no more than minimal impacts to soils and vegetation.

Lease Stipulation D-2 would be highly effective in minimizing surface impacts from exploratory drilling by limiting activities to temporary structures such as ice pads, ice roads, ice airstrips, and temporary platforms, unless permanent structures were absolutely required. Required Operating Procedures and Lease Stipulations E-1 through E-5, and E-8, would be highly effective in protecting soils by providing facility design and construction regulations that would limit the footprint of developments, provide protection from oil spills, place restrictions on the development of gravel pits and permanent roads, and ensure resource issues were considered when deciding on the location of facilities. Lease Stipulation G-1 would restore soil use and productivity by providing for removal of all oil and gas facilities at the time of field abandonment, unless the AO determined that it was in the best interest of the public to retain some or all of the facilities. If facilities were retained, the lease stipulation would be effective in minimizing soil erosion and additional soil disturbance. Lease Stipulation K-1 would prohibit permanent oil and gas facilities near important rivers in the planning area, although essential pipeline and road crossings to the main channel would be permitted; deep-water lakes and Teshekpuk Lake would be given similar protection under Lease Stipulations K-2 and K-3. Lease Stipulation K-8 would be effective in protecting the soils of the Pik Dunes.

4.4.3.4 Conclusion

Under Alternative B, the amount of soil area impacted from oil and gas exploration and development would potentially exceed those of Alternative A as additional high-potential oil and gas areas would be available for leasing. Numerous technological advancements have been made during the decades of operations on the North Slope that have allowed current development activities to proceed with less environmental impact than previous operations (NRC 2003). However, some short-term disturbance and permanent long-term impacts to soils are inevitable. Impacts to soil resources from Alternative B would potentially be somewhat higher than Alternative A as additional high-potential oil and gas areas would be available for

leasing. See Table 4.2-G for a comparison of estimated total surface area disturbed by alternative.

Impacts to soil from management actions under Alternative B would involve short-term disturbance over fairly large areas and long-term disturbance of relatively small areas. However, even though impacts in Alternative B cover more of the planning area than Alternative A (see Table 4.2-G), all areas of soil disturbance would be relatively small as a percentage of the entire planning area (see below). The duration of these impacts could range from one year or less for minor disturbance of soil and vegetation to decades if the soil was destroyed or permafrost thawing was extensive.

Impacts to soils from activities other than oil and gas development under all alternatives would include minor impacts from aircraft landings, archaeological or paleontological excavations, camps, and overland moves. Recovery would vary from 1 year for minor disturbance of soil and vegetation to decades in those areas where soil was excavated or permafrost thawing was extensive.

Impacts from seismic activities would be the same for all alternatives. Short-term impacts could occur on approximately 8,100 acres (0.18 % of the planning area) of soil from 2-D seismic surveys and 100,000 acres (2.2 % of the planning area) of soil from 3-D surveys during a 25-year period (Table 4.2-F).

Approximately 1,250 acres could be impacted short-term by pipeline construction. Short-term impacts would also occur from temporary ice roads, ice pads, and ice runways. For Alternative B, it is estimated that a total of 6,200 miles of ice road would be constructed during the life of the plan impacting approximately 19,000 acres (Table 4.2-G). In addition, approximately 1,020 acres could be impacted by ice pads for exploration and delineation wells and 30 miles of ice runway would be constructed impacting approximately 330 acres. In total, potential short-term impacts to soils under Alternative B from exploration (excluding seismic activities) and development would be approximately 22,000 acres or 0.47% of the planning area. This is greater than Alternative A due to more surface disturbance expected from oil and gas activity.

Oil and gas development and operation would affect soils by compacting and damaging soils under gravel pads, gravel roads, and gravel airstrips, excavating material sites, and constructing VSMs. These impacts would be long-term. Long-term direct and indirect impacts would occur on an estimated 6,100 acres of soil from gravel structures for field and staging area development, and 650 acres from gravel extraction activities. Therefore, these activities could result in long-term impacts to approximately 6,800 (6,100 + 650) acres or 0.15% of the planning area. This is approximately 800 more acres than under Alternative A. The placement of pipelines underground could disturb an additional 1.5 acres per pipeline mile. However, because pipeline burial under tundra has been the exception on the North Slope rather than the norm, it is expected that this activity would disturb only a small amount of area in the planning area.

Impacts associated with spills, the majority of which would be cleaned up immediately, could aversely affect soil resources for a few years to several decades depending on the quantity, location, and season of the spill. The potential for impacts from oil spills would be greater under Alternative B than under Alternative A since more area would be available for development in an area with relatively high oil and gas potential, and the estimated number of large and small spills is slightly greater (see **section 4.2.2, *Oil Spills***).

Under Alternatives B, C, and D some summer tundra travel would be permitted under specific circumstances. Short-term, minor impacts are expected from limited summer tundra travel using low ground pressure vehicles. However, ROP L-1 is designed to regulate and monitor summer travel and minimize impacts to soils and vegetation. Summer travel would only be permitted on a case-by-case basis if the applicant can demonstrate that the proposed use would have no more than minimal impacts to soils and vegetation.

Impacts to soil resources from non-oil and gas activities, and from oil and gas activities, would likely be additive in most cases, except in those areas where the two types of activities overlapped. In these areas the total actual impact could be less than the sum of both impacts because some of the activity would occur on areas already impacted. Impacts to soil resources from exploration and development activities would also be additive, except where development activities occurred in areas previously disturbed during exploration. In areas where two or more activities occurred, overall impacts would reflect those impacts associated with the first activity and any new impacts associated with later activities.

Although soils in all map units identified on Map 3-5 could be impacted during oil and gas exploration and development, soil associated with map units IQ6 and IQ21 (see **section 3.2.7, *Soil Resources*** and Map 3-5) would likely be most affected since they are located in the area having high oil potential. Lease stipulations and ROPs developed for Alternative B would provide protection similar to lease stipulations in Alternative A.

4.4.4 Water Resources

4.4.4-a Surface Water and Groundwater Resources

Because more acreage in the planning area would be open for leasing under Alternative B than under Alternative A, more surface water could be impacted by oil and gas activities under this alternative. However, ROPs and lease stipulations for Alternative B would be effective in protecting water resources. Setbacks from rivers, streams, and fish-bearing lakes would be in the range of ¼ to 3 miles under Alternative B. The main difference between these alternatives pertaining to water resources is that Alternative B allows for drilling within and near Teshekpuk Lake, whereas Alternative A does not allow for drilling near the lake. This greatly increases the likelihood of exploration or development activities impacting water resources and quality in this lake.

4.4.4-a.1 Activities Not Associated With Oil and Gas Exploration and Development

Activities not related to oil and gas exploration and development that could occur in the planning area under Alternative B include aircraft use, watercraft use, collection and excavation for scientific research, hunting camps, recreational use of the area, and use of the area by local natives for subsistence. These activities would be expected to occur at the same frequency and intensity, or slightly greater, as under Alternative A. All of these activities have the potential to impact water resources. However, all of these activities have also been ongoing for many years with minimal impact to water resources.

4.4.4-a.2 Oil and Gas Exploration and Development Activities

Under Alternative B, exploratory and developmental drilling would be allowed on and near Teshekpuk Lake, subject to the setbacks listed in Lease Stipulation K-3 (see **section 2.6.3.2 *Lease Stipulations that Apply to Biologically Sensitive Areas***). Although this lease stipulation is generally protective of the water quality in Teshekpuk Lake, drilling on and near the lake greatly increases the risk for an oil spill in this lake. Therefore, Alternative B is less protective of water resources than the Alternative A, particularly for Teshekpuk Lake. The following analysis is based on **section 4.2.1.2, *Oil and Gas Exploration and Development Activities***. See that section for a description of how estimated areas of disturbance were calculated for each alternative.

Effects of Exploration and Development

Seismic activities and overland travel. Effects to water resources from seismic surveys would be the same as those described for Alternative A unless seismic boats are used in Teshekpuk Lake. Under all of the alternatives, it is projected that three 2-D and two 3-D surveys would be done to fill in gaps in existing surveys.

Ice Road and Pad Construction. Types of impacts from ice road and pad construction would be the same as those described under Alternative A. However, under Alternative B the potential impacts of ice roads on water resources would be greater than under Alternative A because more of the planning area would be open for leasing, and more ice pad and road construction would be likely to occur. For Alternative B, it is estimated that a total of 6,162 miles of ice roads (18,672 acres), 170 exploration and delineation well ice pads (1,020 acres), and 30 ice airstrips (330 acres) would be constructed during the estimated exploration and development scenario resulting in a total of 20,022 acres of short-term surface disturbance. Impacts to the tundra under this alternative should be minimal and limited mainly to the spring when the ice roads and pads would melt and add somewhat saline water to the shallow tundra pools. This impact would likely be temporary in nature, since these ponds will be recharged by local snowmelt and runoff.

Ice Road/Pad Water Use. Types of impacts from ice road/pad water use would be the same as those described under Alternative A. Approximately 50 miles of ice road would be needed each year under all alternatives resulting in the use of approximately 75 million gallons (MG) of water per year (50 miles x 1.5 MG/mile). However, it is estimated that more water would be used over the life of the Plan than under Alternative A since more high oil and gas potential area would be open for exploration and development and ice roads, pads, and airstrips constructed.

Drilling Water & Camp Use. Types of impacts from drilling water use would be the same as those described under Alternative A. Under Alternative B, water withdrawal from lakes for drilling water would be governed by the same lease stipulations as those for ice roads and pads. Therefore, it is expected that impacts to surface water resources would be minor because of lease stipulations governing the amount of drawdown allowed in the lakes, and which lakes could be used as water sources. Because more of the planning area would be open to leasing under Alternative B, more lakes could potentially be impacted by water withdrawal during the winter months than under Alternative A. Lease Stipulations K-1 (Rivers Area) and K-2 (Deep Water Lakes) would be protective of water resources in streams and fish-bearing lakes, but given the greater number of lakes, Alternative B could potentially have more impact on lakes, especially non-fish bearing lakes, than Alternative A.

Snow Compaction. Types of impacts from snow compaction would be the same as those described under Alternative A . Because a greater number of lakes could be affected by snow compaction, under Alternative B impacts to lakes could be greater under this alternative than under Alternative A. Under Alternative B, snow compaction would be prohibited on fish-bearing lakes, except at ice road crossings. Therefore, this alternative would be protective of lakes and streams. No impacts to ice thickness on fish-bearing lakes are expected as a result of oil and gas exploration and development activities. However, lakes without fish could be subject to impacts due to snow compaction if this activity were authorized by the AO.

Drainage Disruption. Types of impacts from disruption of drainage patterns would be the same as those described under Alternative A. Under Alternative B, drainages would be protected by ROPs and lease stipulations. These ROPs and lease stipulations require setbacks from specified rivers, require bridges rather than culverts for crossing major rivers, and require that culverts used for small drainages have ample capacity to handle the flow of the drainage during spring breakup to avoid ice jams. Thus, this alternative would minimize impacts to drainages from construction of permanent and temporary facilities related to crossing the drainage. Overall, impacts to drainages should be minor under this alternative as a result of these lease stipulations.

However, because a greater portion of the planning area would be open to oil and gas leasing under Alternative B, there could potentially be more disruption of drainages than under Alternative A. However, if the lease stipulations and ROPs listed for this alternative are followed, this potential increase in impacts should be minor.

Channel Erosion and Sedimentation. Types of impacts from channel erosion and sedimentation would be the same as those described under Alternative A. Lease stipulations and ROPs developed for Alternative B to mitigate for disturbances to drainages, streams, and rivers by exploration and production activities would be similar to those developed for Alternative A. These lease stipulations and ROPs regulate bridges, culverts, winter crossings, removal of ice bridges, and any temporary facilities constructed near rivers. They also include setbacks for specified rivers. These ROPs and lease stipulations should be effective in minimizing impacts to stream channels. However, because more of the planning area would be open to oil and gas leasing under Alternative B, there would potentially be more channel erosion and sedimentation under this alternative than under Alternative A. If the lease stipulations and ROPs developed for this alternative were followed, this potential increased impact to stream channels should be minor.

Gravel Removal. Types of impacts to water resources from gravel sites would be the same as those described under Alternative A. Under Alternative B, gravel mining sites would not be permitted in the active floodplain of a river, stream, or lake unless authorized by the AO. Gravel mining sites would also to be kept to a minimum in the planning area, and, where possible, be designed so that fish and wildlife could use them after mining was completed. These measures would protect streams, rivers, and lakes and keep impacts to floodplains to a minimum. However, because more of the planning area would be open to oil and gas leasing under Alternative B, there would potentially be more gravel removal under this alternative than under Alternative A. It is possible that 13 gravel mine sites could be necessary, impacting a total of 650 acres (See **section 4.2.1.2**, Table 4.2-G). These are 2 more sites and approximately 100 more acres than estimated for Alternative A. However, lease stipulations and ROPs developed for Alternative B would potentially reduce impacts to streams and lakes from gravel removal.

Pipelines. Types of impacts from pipeline construction and operation would be the same as those described under Alternative A. However, under Alternative B more miles of pipeline could be constructed since more areas of high oil and gas potential are open to development than under Alternative A. Under Alternative B, 412 miles of pipeline would be required resulting in short term disturbance to soils of approximately 1,250 acres. However, ROPs and lease stipulations for Alternative B, such as construction during the winter, would prevent or minimize impacts to water resources

Commercial Gas Development

If commercial gas is developed on the North Slope, impacts to water quality would be similar to those from oil development and similar to those described for Alternative A. Alternative B (as well as Alternatives C and D), which makes more lands available in ice-rich areas especially susceptible to thermokarst, subsidence and erosion, could have greater impacts from burying a gas pipeline. The most notable additional impacts likely to occur to water resources from gas development would be associated with burying a gas pipeline. Potential impacts during burial of a gas pipeline could include temporary impoundments, diversions, and sedimentation. Buried gas lines also have potential thermokarst, subsidence, and erosion problems that could persist beyond the construction phase. If all work on the pipelines is done during winter, these impacts would be greatly reduced. Placement of the gas pipeline on VSMs would also obviate these impacts associated with pipeline burial.

4.4.4-b Surface Water and Groundwater Quality

4.4.4-b.1 Activities Not Associated With Oil and Gas Exploration and Development

Impacts under Alternative B would be expected to be similar to those that would occur under Alternative A and the other alternatives. The only types of non-oil and gas activities in the planning area that are likely to affect freshwater quality would be ongoing subsistence and recreational activities, primarily along rivers and lakes in the ACP, and use of lakes by floatplanes and watercraft. These activities have been ongoing for sometime, and impacts to freshwater quality appear to have been negligible.

4.4.4-b.2 Oil and Gas Exploration and Development Activities

Types of impacts from oil and gas exploration activities under Alternative B would be similar to those described under Alternative A, except that Alternative B allows for drilling within and near Teshekpuk Lake, whereas Alternative A does not allow for drilling near the lake. This greatly increases the likelihood of exploration or development activities impacting water resources and quality in this lake.

Potential surface water quality impacts for oil and gas exploration and development fall into three general source categories: accidental release of fuels and other substances (including oil spills), which could occur during both the construction and operation periods; reductions in dissolved oxygen and changes in ion concentrations in lakes used for water supply, which would occur mainly during construction but could also happen during operations; and increases in terrestrial erosion and sedimentation causing higher turbidity and suspended solids concentrations, which could occur during both the construction and operational periods. The following analysis is based on **section 4.2.1.2, *Oil and Gas Exploration and Development***

Activities. See that section for a description of how estimated areas of disturbance were calculated for each alternative.

Effects of Exploration

Exploration activities that could affect water quality within the planning area under all alternatives would be seismic surveys; ice-road and ice-pad construction; and drilling-fluid storage and disposal. Oil spills would predominantly be attributable to development activities; therefore, spills will be discussed under the analysis of development impacts.

Seismic Activities and Overland Travel. Effects to water resources from seismic surveys would be the same as those described for Alternative A unless seismic boats are used in Teskekpuk Lake. Under all of the alternatives, it is projected that three 2-D and two 3-D surveys would be done to fill in gaps in existing surveys.

Ice Road/Pad Water Use. Types of impacts from ice road/pad water use are the same as those described in Alternative A. For Alternative B, it is estimated that a total of 6,200 miles of ice road would be constructed during the life of the plan impacting approximately 19,000 acres (See **section 4.2.1.2,** Table 4.2-G). In addition, approximately 30 miles of ice runway would be constructed impacting approximately 330 acres. This is somewhat greater water use than that expected for Alternative A. However, as discussed under Alternative A, studies in other areas of the North Slope have shown that water withdrawal from lakes for ice roads and pads has not measurably affected long-term water quality (Baker, 2002; Hinzman, 2006).

Drilling Water Use and Drilling Fluids. Types of impacts from drilling water use would be the same as those described in Alternative A. However, more exploration wells would likely be needed under Alternative B. Under Alternative B, it is assumed 170 exploration and delineation wells would be drilled from ice pads in the planning area. The preferred means of disposing of drilling wastes, including muds and cuttings, would be reinjection into wells, which would not cause impacts to surface water quality. Mud pits and surface discharge of exploration drilling muds and cuttings would be prohibited. Under this scenario, there likely would be a negligible impact to water quality from drilling fluids used in exploration.

Effects of Development

Development activities that could affect water quality in the planning area include spills; excavation of material sites; stream crossings; summer tundra travel; and construction of gravel roads, pads, and airstrips.

Spills. The greatest risk to water quality from oil and gas activity in the planning area is the potential for spills, with impacts dependent upon the size, season and nature of the spill. Effects of spills would be similar to those described in Alternative A. Under Alternative B, however, more of the planning area would be open to exploration and development. Therefore, potential impacts to water quality from oil spills could be somewhat larger than in Alternative A as the estimated number of large and small spills is slightly greater (see **section 4.2.2, *Oil Spills***). In addition, Alternative B allows for drilling within and near Teshekpuk Lake, whereas Alternative A does not allow for drilling near the lake. This greatly increases the likelihood of a spill impacting water resources and quality in this lake.

As noted in the 1998 Northeast IAP/EIS (USDOI BLM and MMS 1998), an oil spill reaching Teshekpuk Lake would likely have a minimal effect on water quality. Dissolved oxygen levels

would not be affected although there may be localized effects. Direct toxicity would be minimal because of the much greater dilution volume in Teshekpuk Lake than in the small ponds and lakes discussed earlier, and because of the relatively unrestricted movement of the slick and underlying water. The spreading of the spill over about 60 acres (0.03% of the lake surface) could be considered an effect on water quality. This effect would persist for a few weeks, until the slick was either cleaned up or the oil stranded on the shoreline. Similar effects would be expected if an oil spill were to reach any of the lakes in the planning area.

Gravel Structures. Types of impacts to water quality from construction of CPFs, gravel roads, pads, and airstrips, and staging areas, would be similar to those described in Alternative A. However, under this alternative, it is estimated that six fields would be developed, resulting in direct impacts of approximately 3,050 acres impacted by gravel placement. It is anticipated that gravel construction would result in indirect impacts of upslope water impoundment and thermokarst erosion equivalent to at least the same area as that directly covered by gravel, or about 3,050 acres for the development assumptions made under this alternative. This is somewhat greater than Alternative A and would increase the potential for thermokarst erosion to result in water features with high turbidity and suspended-sediment concentrations.

Gravel Removal. Types of impacts from development of gravel sites would be the same as those described in Alternative A. Under Alternative B it is possible that 13 gravel mine sites would be necessary, resulting in a total of 650 acres impacted, depending on the actual number of sites required. This is approximately 2 more sites and 100 more acres affected than estimated for Alternative A. Therefore, the potential is greater for impacting water quality locally by an increase in thermokarst and erosion at gravel extraction sites. ROP E-5 is designed to minimize the development footprint and would also minimize the amount of gravel and, therefore, gravel sites. ROP E-8 is designed to minimize the impact of mineral materials mining activities on air, land, water, fish, and wildlife resources. It would require that sites are located outside the active floodplain and would encourage their use for reservoirs and sites for enhancing fish and wildlife habitat. These ROPs would minimize effects to water quality from material sites.

Summer tundra travel. There would be fewer impacts from summer tundra travel under Alternative B than Alternatives C or D. No summer tundra travel is permitted under Alternative A. Short-term, minor impacts are expected from limited summer tundra travel using low ground pressure vehicles. ROP L-1 is designed to regulate and monitor summer travel. Summer travel would be permitted on a case-by-case basis if the applicant can demonstrate that the proposed use would have no more than short term impacts to soils; vegetation; and, therefore, water quality.

Stream Crossings. Types of impacts to water quality from stream crossings would be the same as those described in Alternative A. Under Alternative B, it is estimated that more roads (**see section 4.2.1.2**, Table 4.2-G) and, therefore, steam crossings could be necessary to reach areas of high oil and gas potential. The potential for constricting flows and creating increased stream velocities, ice jams, ice impacts, scour, and streambank erosion would be greater. However, Lease Stipulations 42, 43, and 44 provide guidance on the use of bridges and culverts that would help ensure natural drainage pattern are maintained.

Pipelines. Types of impacts from pipeline construction and operation would be the same as those described in Alternative A. Under Alternative B, given the potentially greater number of fields developed, impacts from pipeline construction would be greater than those described for Alternative A. Under Alternative B, 412 miles of pipeline would be required resulting in short

term disturbance to soils of approximately 1,250 acres and a long-term impact at VSM sites of approximately 2 acres (see **section 4.2.1.2,** Table 4.2-G).

The extent of impacts associated with buried pipeline could also be greater under Alternative B given the potentially greater number of fields developed. Because pipeline burial under tundra has been the exception on the North Slope rather than the norm, it is expected that this activity would disturb only a small amount of area in the planning area.

Effects of Abandonment and Rehabilitation

Types of effects from abandonment and rehabilitation would be the same as those described in Alternative A. Under Alternative B, given the potentially greater number of fields developed, impacts from abandonment and rehabilitation would be greater than those described for Alternative A. See **section 4.2.1.2,** Table 4.2-G for a comparison of areas impacted by infrastructure that would need to be rehabilitated. Lease Stipulation G-1 could require removal and reclamation of the developed site(s) upon field abandonment, which would eventually result in restoration of the natural drainage.

Commercial Gas Development

If commercial gas is developed on the North Slope, impacts to water quality would be similar to those from oil development, though there would be no oil spill impacts, and similar to those described for Alternative A. Alternative B (as well as Alternatives C and D), which makes more lands available in ice-rich areas especially susceptible to thermokarst, subsidence and erosion, could have greater impacts from burying a gas pipeline. The most notable additional impacts likely to occur to water quality from gas development would be associated with burying a gas pipeline. Potential impacts during burial of a gas pipeline could include temporary impoundments, diversions, and sedimentation. Buried gas lines also have potential thermokarst, subsidence, and erosion problems that could persist beyond the construction phase. If all work on the pipelines is done during winter, these impacts would be greatly reduced. Placement of the gas pipeline on VSMs would also obviate these impacts associated with pipeline burial.

4.4.4.3 Effectiveness of Stipulations and Required Operating Procedures

Under Alternative B, the lease stipulations and ROPs listed in Table 2-2 and summarized in the paragraph below would potentially protect water resources because they would require setbacks from rivers and fish-bearing lakes for oil and gas activities, place limits on the withdrawal of water from fish-bearing lakes, and regulate the construction of gravel roads, ice roads and pads, and pipelines. Also, oil spill prevention and response procedures would be required, as would oil spill clean-up procedures. Refueling would be regulated and thereby kept away from rivers and lakes, particularly fish-bearing lakes. The required snowpack would be present on the tundra before seismic equipment would be allowed to make overland moves during winter. Drilling would not be allowed in streams, rivers, or fish-bearing lakes.

Several lease stipulations and ROPs would protect water quality under Alternative B. Required Operating Procedures A-1 through A-7 would regulate garbage, wastewater, drilling wastes, fuel and chemical storage, fuel handling, and spill prevention and clean-up plans. Required Operating Procedure B-1 would prohibit water withdrawal from rivers during winter and ROP B-2 would regulate amounts of winter water withdrawals from lakes. Required Operating Procedures C-2 through C-4 would regulate overland moves, seismic work, ice-road

construction, and other heavy equipment travel during the winter to limit impacts to water resources. Lease Stipulation D-1 would limit exploratory drilling in shallow lakes, streams, and floodplains, but would allow exceptions if there was no feasible or prudent alternative.

Required Operating Procedures and Lease Stipulations E-2, E-3, E-6, and E-8 would limit certain facility, structure, and gravel mine site design and construction impacts near lakes and rivers, but would allow exceptions if there was no feasible or prudent alternative. ROP E-5 is designed to minimize the development footprint and would also minimize the amount of gravel and, therefore, gravel sites. ROP E-8 is designed to minimize the impact of mineral materials mining activities on air, land, water, fish, and wildlife resources. It would require that sites are located outside the active floodplain and would encourage their use for reservoirs and sites for enhancing fish and wildlife habitat. These ROPs would minimize effects to water quality from material sites. Lease Stipulation G-1 could require removal and reclamation of the developed site(s) upon field abandonment, which would eventually result in restoration of the natural drainage. Lease Stipulation K-1 would be equally effective as Alternative A Lease Stipulation 39 in protecting aquatic, floodplain, and riparian areas adjacent to rivers identified as having critical aquatic and riparian habitat, except in certain large rivers. Lease Stipulation K-2 would also be equally effective as Alternative A Lease Stipulation 39 in protecting aquatic and riparian areas adjacent to deepwater lakes, but would allow exceptions if there were no feasible or prudent alternatives.

4.4.4.4 Conclusion

Under all alternatives, this analysis shows that impacts to water resources from non-oil and gas activities would be minor. Most impacts from and oil and gas exploration would also be minor and short-term. Short-term impacts include water withdrawals from lakes for ice roads and ice pads. Seismic activities could result in thermokarst and erosion on approximately 153 acres during a 25-year period under all alternatives.

Under Alternative B, the amount of area impacted from oil and gas exploration and development would potentially exceed those of Alternative A as additional high-potential oil and gas areas would be available for leasing. Therefore, potential impacts to water resources from development infrastructure such as CPFs, roads, pads, runways, pipelines, pump stations, staging bases, and material sites would also be greater (see **section 4.2.1.2,** Table 4.2-G, for a comparison of infrastructure by alternative). Long-term impacts from development of CPFs, gravel roads, pads, runways, pump stations, and staging bases could have direct impacts of approximately 3,050 acres and indirect impacts of approximately 3,050 acres under Alternative B. Impacts could include disturbance of stream banks or shorelines and subsequent thawing of permafrost (thermokarst); and blockages of natural channels and floodways which would disrupt drainage patterns. Excavation of material sites would also result in a loss of approximately 650 acres. Total long-term impacts would total 6,750 acres.

Under Alternative B, it is estimated that more roads and, therefore, steam crossings could be necessary to reach areas of high oil and gas potential than under Alternative A. The potential for constricting flows and creating increased stream velocities, ice jams, ice impacts, scour, and streambank erosion would be greater. However, Lease Stipulations 42, 43, and 44 provide guidance on the use of bridges and culverts that would help ensure natural drainage pattern are maintained.

The greatest risk to water quality from oil and gas activity in the planning area is the potential for spills. Under Alternative B, the estimated number and volume of large and small spills

would be greater than those estimated for Alternative A since additional high oil potential areas would be available for development. In addition, there is greater potential for a spill from oil and gas activities to affect water quality in Teshekpuk Lake as the Lake, and some area surrounding the lake, would be available for oil and gas leasing.

Impacts to water resources from non-oil and gas activities, and from oil and gas activities, would likely be additive, except in those areas where the two types of activities overlapped. Impacts to water sources from exploration and development activities would also be additive, except where development activities occurred in areas previously disturbed during exploration. In areas where two or more activities occurred, overall impacts would reflect those impacts associated with the first activity and any new impacts associated with later activities.

Numerous technological advancements have been made during the decades of operations on the North Slope that have allowed current development activities to proceed with less environmental impact than previous operations (NRC 2003). While any surface-disturbing activity could affect water resources, the lease stipulations and ROPs under Alternative B would help mitigate impacts to these resources.

4.4.5 Vegetation

4.4.5.1 Activities Not Associated With Oil and Gas Exploration and Development

Under Alternative B, impacts to vegetation associated with non-oil and gas activities would be similar to those described under Alternative A. These activities could occur throughout the planning area, and at the same frequency and intensity as under Alternative A, despite the increased availability of land for oil and gas leasing. There could be some increased use of OHVs in the planning area due to an increase in the amount of roads associated with development occurred. However, additional impacts to vegetation from this increase would likely be small.

4.4.5.2 Oil and Gas Exploration and Development Activities

Effects of Disturbances

Various activities associated with oil and gas exploration, development, and production could impact vegetation in the planning area. These activities include seismic operations, exploration drilling, gravel road, pad, and airstrip construction, pipeline construction, and construction of ice roads and ice pads.

Exploration

Under Alternative B, types of impacts to vegetation from activities associated with oil and gas exploration would be similar to those that occur under Alternative A, except that there would be a greater number of exploration and delineation wells drilled, which would increase the impacts of well collar construction and the number and impacts of both ice pads and ice roads.

Under Alternative B, the same scenario for seismic exploration is assumed as for Alternative A. Short-term vegetation disturbance from 2-D and 3-D operations combined would total a maximum of 107,996 acres (2.3% of the 4.6 million acres planning area). Long-term disturbance is estimated to total 153 acres.

During the life of the plan, it is assumed that 97 exploration wells and 73 delineation wells, or a total of 170 wells, would be drilled from ice pads in the planning area under Alternative B. At six acres per pad, these would impact 1,020 acres of tundra, spread out over 50 years (13% more than Alternative A). Assuming that 4% (seven) of these would also involve an over-summer ice pad, an additional 42 acres of vegetation would be affected by ice pads.

Under Alternative B, ice road construction would also increase in terms of total miles constructed because of an increase from five to six in number of total fields discovered. The total acreage of short term disturbance from ice roads over 50 years would be 18,672, about 20% more than for Alternative A. Since vegetation recovery from ice road impacts is expected within a few years (Yokel et al. in press), long-term disturbance from ice roads would be negligible. Although some evidence of crushed tussocks may still be apparent, new growth would preclude any exposed soils.

Ice airstrips are also used during exploratory drilling, and under Alternative B it is assumed that 30 ice airstrips would be constructed covering 11 acres each for a total of 330 acres (50% more than under Alternative A). These airstrips are commonly built on the grounded ice of large lakes, but if they were built over tundra they would result in impacts similar to ice roads.

The construction of well cellars during exploration requires the digging of a hole that destroys vegetation on approximately 16 square feet (0.0004 acres) of ground. Thermokarst associated with the disruption of thermal regime in the surrounding soil may also change the vegetation type around the well cellar to a wetter vegetation type. These impacts could result in 0.06 acres of vegetation being destroyed under Alternative B (13% more than under Alternative A).

Development

During oil and gas development and production, various activities could cause impacts to vegetation in the planning area. These activities include construction and use of gravel pads, roads, airstrips, and pipelines, excavation of material sites, and construction of ice roads and ice pads. Ice roads and pads are covered above.

Placement of Gravel Fill. Construction of CPFs and associated satellite pads, roads, staging areas, and airstrips would result in the destruction of vegetation in the areas of gravel placement. Under this alternative, six CPFs and associated satellite pads, roads and airstrips, six pump stations, and three staging bases would be developed, resulting in 3,064 acres of vegetation destroyed by gravel placement (13% more than under Alternative A).

The increased facilities construction and use under Alternative B would result in a larger area impacted by dust than under Alternative A. Assuming a total of 250 miles of in-field gravel roads and 6 miles of airstrips, there is a potential for a total perimeter of 512 miles. Within 30 feet of gravel fill, up to 1,862 acres of vegetation could be subject to smothering by dust and gravel, and another 7,447 acres could be affected by a dust shadow

Construction of gravel pads, roads, and airstrips could alter the moisture regime of tundra near the structure by changing natural drainage patterns and areas where snow accumulates. Snowdrifts caused by gravel structures increase the wintertime soil surface temperature and increase thaw depth in soils near the structures. These impacts are exacerbated by dust deposition (described above) and by the formation of impoundments (described below). These factors could combine to warm the soil, deepen thaw, and produce thermokarst adjacent to roads and other gravel structures (NRC 2003). Additionally, these changes could alter the

species composition of the plant community near gravel structures. In general, most changes in the plant community around gravel structures would occur within 164 feet of the structure. If all effects were to occur within this zone, approximately 10,178 acres would be impacted under Alternative B (9% more than under Alternative A). Note that this area includes the 9,309 acres affected by dust above, and is not in addition to it.

Material Sites. Gravel required for development in the planning area could be mined from existing sites east of the planning area or could be extracted from new sites developed within the planning area. Investigations to identify gravel sources in the planning area have not been conducted, but presumably would be initiated if discoveries of recoverable oil or gas were made. Under Alternative B it is assumed that 13 material sites, each affecting 50 acres, would be needed. This would cover a total area of 650 acres (18% more than under Alternative A). Excavation of the gravel mine and stockpiling of overburden would destroy vegetation at these sites.

Pipelines. Under Alternative B, types of impacts from oil pipeline construction would be similar to those described for Alternative A. The total area disturbed by each VSM would be about 14 square feet. About 6% of this area would be vegetation destroyed and replaced by the VSM, and the remaining portion would be potentially altered in terms of community type or species composition. Overall, 0.03 acres of vegetation would be disturbed per pipeline mile. Under Alternative B, 250 miles of gathering lines and 162 miles of sales-oil pipelines would disturb 12-13 acres of vegetation through VSM placement, or about 5% more than under Alternative A.

Summer Tundra Travel. On a case-by-case basis, BLM may permit low-ground-pressure vehicles to travel off of gravel pads and roads during periods other than when the ground is frozen and covered with snow. This is expected to be an uncommon occurrence, and if permitted at all it would likely be only during late summer to fall. Because of restrictions that would be placed on this activity, impacts to vegetation should be limited to the compression of standing vegetation, similar to what happens during winter following traffic by low-ground-pressure vehicles.

Air Pollution. The potential for impacts to vegetation from air pollution would be greater under Alternative B, given the potential for additional oil fields and processing facilities, as compared to Alternative A. However, it is unlikely that there would be substantial impacts to vegetation from pollutants in the planning area under either alternative.

Abandonment and Rehabilitation

During abandonment activities, vegetation and wetlands would be impacted by dust fallout along roads, by ice roads and other off-road tundra travel associated with dismantling of pipelines and power lines, and by disturbance to vegetation adjacent to VSMs and power line poles during their removal. The level of impact from these activities would be roughly the same as that during construction if gravel fill was removed; impacts would be less if the gravel were to be left in place. If roads and pads were left in place, and especially if cross drainage across roads was not maintained, water impoundment would occur, and could alter plant communities as described for the construction period. It is also likely that the unmaintained roads would have occasional washouts, where tundra vegetation would be covered with washed-out gravel. Roads and pads, if left in place, would likely need to be revegetated with plants native to gravel bars and ridges in the Arctic (i.e., different from the plant communities surrounding the facilities). Revegetation activities could take several years, as initial attempts are not always

successful. Removal of gravel from pads, roads, and airstrips could be mandated. Partial or complete removal of gravel can result in faster reestablishment of native plant growth, although establishment can take many years (more than a decade). In addition, thaw subsidence is difficult to predict, and complete restoration to preexisting conditions is not likely.

Effects of Spills

The greater amount of leasing, development, and production of oil that would occur under Alternative B, relative to Alternative A, would result in a greater number of small spills of crude and refined oil in the planning area. The chance of a large oil spill occurring would also be greater under Alternative B; however, it would still be a rare event.

Most oil spills cover less than 500 square feet (<0.01 acres), although a pressured aerial mist may cover up to 145 acres (Ott 1997). (Such a spill is a very low probability event, occurring less than once out of the total spills expected throughout the life of this plan. Thus its magnitude is not apparent in the following acreages.) The average spill would cover 0.1 acre. If 11% of all oil spills would reach vegetation during summer, under Alternative B this would mean 227 of the 2,070 crude and refined oil spills assumed to occur over the life of the plan would have more than a negligible effect on vegetation. Assuming the average spill would cover 0.1 acre, under Alternative B approximately 23 acres would be impacted substantially during the lifetime of development in the planning area. This is about 10% more than the acreage impacted under Alternative A. Overall, past spills on Alaska's North Slope have resulted in minor ecological damage and ecosystems have shown good potential for recovery (Jorgenson 1997).

Commercial Gas Development

The 162-mile-long buried gas pipeline projected for Alternative B (as well as Alternatives A and D) would destroy about 80 acres of vegetation directly through excavation of a 4-foot-wide trench and, potentially, alter 210 acres along an approximately 11-foot-wide strip where compaction and other indirect effects from use of machinery and temporary storage of overburden would occur. Because of the difficulty colonizing species would have invade such a wide area, a recovery time of several years or longer may be expected, though wetter areas would generally revegetate before drier areas (McKendrick, 2000). In addition, vegetation would be lost to a 10- to 20-acre compressor station pad. Placement of gas pipelines on VSMs, would generally reduce impacts to vegetation as described for Alternative A.

4.4.5.3 Effectiveness of Stipulations and Required Operating Procedures

Many of the lease stipulations and ROPs associated with Alternative B would directly or indirectly limit potential impacts to vegetation in the planning area. ROPs A-1 through A-7 relate to waste prevention, handling, disposal, spills, and public safety. They ensure that waste materials associated with exploration and development activities would be properly disposed of and would effectively minimize impacts to vegetation from spills and mishandling of materials. They would also provide for rapid cleanup of spills, decreasing the likelihood of impacts to vegetation. ROPs C-2 and C-3 would minimize impacts to vegetation associated with overland moves and seismic work.

Lease Stipulation D-1 would effectively protect riparian habitat by preventing exploratory drilling in rivers, streams, and active floodplains. Lease Stipulation D-2 would effectively minimize surface impacts from exploratory drilling by limiting activities to temporary structures such as ice pads, ice roads, ice airstrips and temporary platforms unless permanent

structures were absolutely required. ROPs and Stipulations E-1 through E-6, E-8, and E-12 would effectively minimize impacts to vegetation by providing facility design and construction regulations that would limit the footprint of developments, provide protection from oil spills, provide setbacks that protect riparian and other high value habitats, and insure that habitat and resource issues were considered in the placement of facilities. Lease Stipulation G-1 would provide for the removal of all oil and gas facilities at the time of field abandonment unless the AO determined that facilities should be left in place. ROP I-1 would help be effective in minimizing resource conflicts by providing appropriate orientation programs and training for facilities workers. Lease Stipulation J-1 would be effective in protecting threatened and endangered species within the planning area. All of the "K" lease stipulations would also be effective by providing some protection for vegetation by providing for setbacks along the coast, rivers, lakes, and other high value habitat areas.

Under Alternative B, development would result in more impacts to vegetation and plant communities than under Alternative A. The ROPs and lease stipulations associated with Alternative B are similar in intent to those of Alternative A and would provide protections to limit impacts by minimizing destruction of vegetation and alteration of plant communities.

4.4.5.4 Conclusion

Under Alternative B, impacts to vegetation from activities other than oil and gas development would be similar to those under Alternative A and would include minor impacts from aircraft landings, archaeological or paleontological excavations, camps, and overland moves. The duration of these impacts would be short term, ranging up to five months, and recovery would vary from one to several years.

As for Alternative A, impacts to vegetation from oil and gas exploration under Alternative B would occur from seismic work and construction of well cellars during exploratory drilling and the construction of ice roads and ice pads. The duration and recovery time for impacts associated with seismic work would be similar to those for overland moves and the same as for Alternative A. Based on earlier studies, there should be no substantial, long-term impacts to vegetation from seismic lines, but camp move trails could substantially impact approximately 153 acres after 8-9 years. Effects of well cellar construction would also be permanent, but would impact only one acre of vegetation.

The effects of oil and gas development and operation would include destruction of vegetation during construction of gravel pads (CPFs, satellite drill pads, pump stations, and staging bases), roads, airstrips, and staging areas; from excavation of material sites and burial of gas pipelines; and construction of VSMs. These impacts would be long-term and would impact about 3,716 acres, or 0.08% of the 4.6 million acre planning area (as compared to 0.07% under Alternative A). (An additional 80 acres would be destroyed through burial of gas pipelines). Plant communities could also be altered by dust deposition, salinity of gravel fill used in construction, snow drifts, and blockage of or change to natural drainage patterns. These impacts would be also be long-term and would impact about 10,178 acres, or 0.2% of the planning area (9% more than the amount of vegetation impacted under Alternative A).

It is assumed that impacts to vegetation types or communities would occur in proportion to their occurrence within the planning area. However, increased development in the area around Teshekpuk Lake, which would be allowed under Alternative B, could disproportionately impact wetland vegetation classes compared to Alternative A. A higher percentage of wet vegetation communities occur in areas in the northern portion of the planning area. This area is also

considered to have the highest potential for oil reserves, which would increase the likelihood that these areas would be developed under Alternative B.

Under Alternative B, development would be unlikely to substantially harm plant species or communities. However, if development facilities were constructed in an area containing a population of a rare plant species, the impacts to that species could be severe. Three rare North Slope plant species are known to occur in the planning area, and four other rare species are known to occur on the North Slope but have not been documented in the Northeast NPR-A. Sabine grass is an aquatic grass that rarely occurs between the pendent grass and sedge zones in lakes and ponds. This species is known from a few locations north and northeast of Teshekpuk Lake, which would be protected from development under Alternative B as part of the 213,000 acres unavailable for leasing under this alternative. Stipulated cinquefoil has been found at Umiat. This Asian species is found in sandy substrates, such as sandy meadows, and riverbank silts and sands other than dunes. This species would be protected by setbacks along rivers in the planning area and by the designation of the Colville River Special Area. Muir's fleabane, Drummond's bluebell, and Hartz's bluegrass all occur in dry habitats associated with bluffs, floodplains, river terraces, sand dunes, rocky outcrops and fellfields. These habitats are the primary sources of gravel fill used during construction and development (NRC 2003) and could be impacted by development in these areas.

Impacts to vegetation from non-oil and gas activities, and from oil and gas activities, would likely be additive, except in those areas where the two types of activities overlapped. Impacts to vegetation from exploration and development activities would also be additive, except where development activities occurred in areas previously disturbed during exploration. In areas where two or more activities occurred, overall impacts would reflect those impacts associated with the first activity and any new impacts associated with later activities.

4.4.6 Wetlands and Floodplains

Because more acreage in the planning area would be open for leasing under Alternative B than under Alternative A, more wetlands and floodplains could be impacted by oil and gas activities under this alternative. However, ROPs and performance-based lease stipulations for Alternative B would mitigate impacts to wetlands and floodplains. Setbacks from rivers, streams, and fish-bearing lakes would be in the range of ¼ to 3 miles under Alternative B. The main difference between these alternatives pertaining to wetlands is that Alternative B allows for drilling within and near Teshekpuk Lake, whereas Alternative A does not allow for drilling within or near the lake. This greatly increases the likelihood of exploration or development activities impacting wetlands and floodplains in the vicinity of this lake. Approximately 95% of the planning area would be considered wetlands, according to established criteria for determining wetland status. It is likely and therefore assumed that all ground-disturbing actions will be impacting wetlands for the purposes of calculating short and long-term impacts.

4.4.6.1 Activities Not Associated With Oil and Gas Exploration and Development

Activities not related to oil and gas exploration and development that could occur in the planning area under Alternative B include aircraft, watercraft, OHV and snowmachine use, overland moves, collection and excavation for scientific research, hunting camps, recreational use of the area, and use of the area by local natives for subsistence. These activities, described in Alternative A, could occur throughout the planning area, and at the same frequency and

intensity as under Alternative A, despite the increased availability of land for oil and gas leasing. There could be some increased use of OHVs in the planning area due to an increase in the amount of roads associated with development. However, additional impacts to wetlands and floodplains from this increase would likely be small.

4.4.6.2 Oil and Gas Exploration and Development Activities

The following analysis is based on **section 4.2.1.2, *Oil and Gas Exploration and Development Activities***. See that section for a description of how estimated areas of disturbance were calculated for each alternative.

Effects of Disturbances

Various activities associated with oil and gas exploration, development and production could impact wetlands and floodplains in the planning area. These activities include seismic operations, exploration drilling, construction of ice roads and ice pads, summer tundra travel, gravel roads, gravel pads for pump stations, CPFs, and staging bases, airstrip and pipeline construction, and gravel mine sites.

Exploration

During oil exploration, various activities could cause impacts to wetlands and floodplains in the planning area. These activities include seismic operations, exploration drilling, and construction of ice roads, pads and airstrips. The types of impacts to wetlands and floodplains from exploration activities were described in Alternative A.

Under Alternative B, impacts to wetlands and floodplains from activities associated with oil and gas exploration would be greater than those that occur under Alternative A, because there would be an additional 19 exploration and delineation wells drilled, which would increase the impacts of well cellar construction and the number and impacts of both ice pads and ice roads.

Under Alternative B, the same scenario for seismic exploration is assumed as for Alternative A. Short-term vegetation disturbance from 2-D and 3-D operations is expected to total 108,000 acres (2.3% of the 4.6 million acre planning area). Long-term disturbance is estimated to total 153 acres.

During the life of the plan, it is assumed that 97 exploration wells and 73 delineation wells, or a total of 170 wells, would be drilled from ice pads in the planning area under Alternative B. At six acres per pad, these would impact 1,020 acres of tundra, spread out over 50 years (114 acres more than Alternative A). Assuming that 4% (seven) of these would also involve an over-summer ice pad, an additional 42 acres of vegetation would be affected by ice pads.

Under Alternative B, ice road construction would also increase in terms of total miles constructed because of an increase from five to six in number of total fields discovered. The total acreage of short term disturbance from ice roads over 50 years would be 18,672, about 3,030 acres more than for Alternative A. Since vegetation recovery from ice road impacts is expected within a few years (Yokel et al. in press), long-term disturbance from ice roads would be negligible. Although some evidence of crushed tussocks may still be apparent, new growth would preclude any exposed soils.

Ice airstrips are also used during exploratory drilling, and under Alternative B it is assumed that 30 ice airstrips would be constructed (10 more than Alternative A) covering 11 acres each for a total of 330 acres. These airstrips are commonly built on the grounded ice of large lakes, but if they were built over tundra they would result in impacts similar to ice roads.

The construction of well cellars during exploration requires the digging of a hole that destroys vegetation on approximately 16 square feet (0.00037 acres) of ground. Thermokarst associated with the disruption of thermal regime in the surrounding soil may also change the vegetation type around the well cellar to a wetter vegetation type. The impacts from 170 wells could result in 0.06 acres of vegetation being destroyed under Alternative B.

Development and Production

During oil development and production, various activities could cause impacts to wetlands in the planning area. These activities include construction of gravel pads for pump stations, staging bases and CPFs, roads, airstrips, pipelines, excavation of material sites, summer tundra travel, and construction of ice roads. Impacts of ice roads were discussed previously under the "Exploration" subheading and more thoroughly in Alternative A.

Placement of Gravel Fill. Types of impacts to wetlands and floodplains from placement of gravel fill were described in Alternative A. Construction of CPFs and associated satellite pads, roads, staging areas, and airstrips would result in the destruction of vegetation in the areas of gravel placement. Under Alternative B, six oil fields, six pump stations, and three staging bases would be developed, resulting in 3,064 acres of wetlands destroyed by gravel placement (346 acres more than Alternative A).

The increased facilities construction and use under Alternative B would result in a larger area impacted by dust than under Alternative A. Assuming a total of 250 miles of in-field gravel roads and 6 miles of airstrips, there is a potential for a total perimeter of 512 miles. Within 30 feet of gravel fill, up to 1,862 acres of vegetation could be subject to smothering by dust and gravel, and between 30 and 150 feet, another 7,447 acres of altered vegetation for a total of 9,309 acres that could be affected by a dust shadow out to a distance of 150 feet. In general, most changes in the plant community around gravel structures would occur within 164 feet of the structure (Woodward-Clyde Consultants 1983). If all effects were to occur within this 164 foot zone, a total of 10,178 acres would be affected.

Stream Crossings. Types of impacts to floodplains and stream crossings from installation of culverts, bridges or pipelines were described in Alternative A. An additional 20 miles of infield gravel roads and one additional runway, CPF, and two more production pads are expected under Alternative B than under Alternative A. For this reason it is expected that more stream crossings will be needed, and the potential for constricting flows and creation of increased stream velocities, ice jams, ice impacts, scour and streambank erosion would be greater under Alternative B. However, ROP E-6 is protective of stream crossings by requiring crossings to be designed and constructed to maintain natural drainage and minimize adverse effects to natural stream flow.

Material Sites. Types of impacts to wetlands and floodplains from material sites were described in Alternative A and are similar for all Alternatives. Gravel required for development in the planning area could be mined from existing sites east of the planning area or could be extracted from new sites developed within the planning area. Investigations to identify gravel sources in the planning area have not been conducted, but presumably would be initiated if

discoveries of recoverable oil or gas were made. Under Alternative B it is assumed that 13 material sites, each affecting 50 acres, would be needed. This would cover a total area of 650 acres, which is 100 acres more than estimated for Alternative A Excavation of the gravel mine and stockpiling of overburden would destroy wetlands and floodplains at these sites. ROP E-8 minimizes impacts to wetlands and floodplains by placing material sites outside of floodplains, or within floodplains if water reservoirs can be utilized and fish habitat increased.

Pipelines. Types of impacts to wetlands and floodplains from pipelines were described in Alternative A. Impacts under Alternative B from pipeline construction would be similar to those described for Alternative A. The total area disturbed by each VSM would be about 14 square feet. About 6% of this area would be destroyed vegetation and subsequently replaced by the VSM, and the remaining portion would be potentially altered in terms of community type or species composition. Overall, 0.03 acres of vegetation would be disturbed per pipeline mile. Under Alternative B, 250 miles of gathering lines and 162 miles of sales-oil pipelines would disturb up to 13 acres of vegetation through VSM placement (1 acre more than Alternative A).

Effects of Spills. The greater amount of leasing, development, and production of oil that would occur under Alternative B, relative to Alternative A, would result in a greater number of small spills of crude and refined oil in the planning area. The chance of a large oil spill occurring would also be greater under Alternative B; however, it would still be a very rare event.

Most oil spills cover less than 500 square feet (<0.01 acres), although a pressured aerial mist of 1-4 bbls may cover up to 145 acres (Ott 1997). (Such a spill is a very low probability event, occurring less than once out of the total spills expected throughout the life of this Plan. Thus its magnitude is not apparent in the following acreages.) See **section 4.3.5.2** under the vegetation section for a more thorough analysis of potential impacts to vegetation and wetlands from spills. If 11% of all oil spills would reach vegetation under Alternative B this would mean 228 of the 2,070 crude and refined oil spills assumed to occur over the life of the plan would have more than a negligible effect on vegetation. This is about 27 more spills than the amount that would be impacted under Alternative A. Assuming the average spill would cover 0.1 acre, under Alternative B approximately 23 acres would be impacted substantially during the lifetime of development in the planning area. Overall, past spills on Alaska's North Slope have resulted in minor ecological damage and ecosystems have shown good potential for recovery (Jorgenson 1997).

Summer Tundra Travel. Types of impacts to wetlands from summer tundra travel were described in Alternative A and are similar for all Alternatives. Given the potentially greater number of fields developed, impacts from summer tundra travel under Alternative B could also be greater than under Alternative A. Short-term, minor impacts are expected from limited summer tundra travel using low ground pressure vehicles. ROP L-1 is designed to regulate and monitor summer travel. Summer travel would be permitted on a case-by-case basis if the applicant can demonstrate that the proposed use would have no more than minimal impacts to soils and vegetation.

Abandonment and Rehabilitation

Alternative B may require removal of structures or rehabilitation of 3,716 acres (446 acres more than Alternative A) During abandonment activities, vegetation and wetlands would be impacted by dust fallout along roads, by ice roads and other off-road tundra travel associated with dismantling of pipelines and power lines, and by disturbance to vegetation adjacent to VSMs

and power line poles during their removal. The level of impact from these activities would be roughly the same as that during construction if gravel fill was removed; impacts would be less if the gravel were to be left in place. If roads and pads were left in place, and especially if cross drainage across roads was not maintained, water impoundment would occur, and could alter plant communities as described for the construction period. It is also likely that the unmaintained roads would have occasional washouts, where tundra vegetation would be covered with washed-out gravel. Roads and pads, if left in place, would likely need to be revegetated with plants native to gravel bars and ridges in the Arctic (i.e., different from the plant communities surrounding the facilities). Revegetation activities could take several years, as initial attempts are not always successful. Removal of gravel from pads, roads, and airstrips could be mandated. Partial or complete removal of gravel can result in faster reestablishment of native plant growth, although establishment can take many years (more than a decade). In addition, thaw subsidence is difficult to predict, and complete restoration to preexisting conditions is improbable. Lease Stipulation G-1 would provide for the removal of all oil and gas facilities at the time of field abandonment unless the AO determined that facilities should be left in place.

Commercial Gas Development

Development of commercial gas in the planning area would reflect the impacts described for soils, water, and vegetation and would be similar to that described for Alternative A. The same length of buried gas pipelines is projected, as well as the same impacts from construction of a 10- to 20-acre pad for a gas compressor station. Alternative B (as well as Alternatives C and D), which makes more lands available in ice-rich areas especially susceptible to thermokarst, subsidence and erosion, could have greater impacts from burying a gas pipeline. Placement of gas pipelines on VSMs, would reduce these impacts, though vegetation and soils would be destroyed at base of the VSMs, vegetation under aboveground pipelines would be impacted by shading, and ice roads that may be used during construction would have localized, short-term impacts on vegetation and during spring melting add somewhat saline water to any shallow tundra pools.

4.4.6.3 Effectiveness of Stipulations and Required Operating Procedures

Many of the performance-based lease stipulations and ROPs associated with Alternative B would directly or indirectly limit potential impacts to vegetation in the planning area. ROPs A-1 through A-7 relate to waste prevention, handling, disposal, spills, and public safety. They ensure that waste materials associated with exploration and development activities would be properly disposed of and would effectively minimize impacts to vegetation from spills and mishandling of materials. They would also provide for rapid cleanup of spills, decreasing the likelihood of impacts to vegetation. ROPs C-2 and C-3 would minimize impacts to vegetation associated with overland moves and seismic work.

Lease Stipulation D-1 would limit impacts to floodplains by preventing exploratory drilling in rivers, streams, and active floodplains. Lease Stipulation D-2 would effectively minimize surface impacts from exploratory drilling by limiting activities to temporary structures such as ice pads, ice roads, ice airstrips and temporary platforms unless permanent structures were absolutely required. ROPs and Stipulations E-1 through E-6, E-8, and E-12 would effectively minimize impacts to vegetation by providing facility design and construction regulations that would limit the footprint of developments, provide protection from oil spills, provide setbacks that protect riparian and other high value habitats, and insure that habitat and resource issues were considered in the placement of facilities. Lease Stipulation G-1 would provide for the removal of

all oil and gas facilities at the time of field abandonment unless the AO determined that facilities should be left in place. ROP I-1 would help be effective in minimizing resource conflicts by providing appropriate orientation programs and training for facilities workers. All of the "K" lease stipulations would also be effective by providing some protection for vegetation by providing for setbacks along the coast, rivers, lakes, and other high value habitat areas.

Under Alternative B, development would result in more impacts to wetlands and floodplains than under Alternative A. The ROPs and performance-based lease stipulations associated with Alternative B are expected to be equally protective as those of the prescriptive stipulations in Alternative A. They would provide extensive protections to limit impacts, and would be effective in minimizing destruction of wetlands and floodplains.

4.4.6.4 Conclusion

Under Alternative B, impacts to wetland and floodplains from activities other than oil and gas development would be similar to those under Alternative A and would include minor impacts from aircraft, watercraft, OHV and snowmachine use, overland moves, collection and excavation for scientific research, hunting camps, recreational use of the area, and use of the area by local natives for subsistence. The duration of these impacts would be short term, ranging up to 5 months, and recovery would vary from one to several years.

Impacts to wetlands and floodplains from oil and gas exploration would occur from seismic work, construction of well cellars during exploratory drilling, and the construction of ice roads, pads, and airstrips. Based on earlier studies, there should be no substantial, long-term impacts to vegetation from seismic lines, but camp move trails could substantially impact approximately 153 acres after 8-9 years. Effects of well cellar construction would also be permanent, but would impact only one acre of vegetation.

The effects of oil development and operation would include destruction of vegetation during construction of gravel pads, roads, airstrips, and staging areas; from excavation of material sites; and construction of VSMs. These impacts would be long-term and would impact about (3,064 + 650 + 13) or 3727 acres, (447 acres more than Alternative A) or 0.08% of the 4.6 million acre planning area. Wetland plant communities could also be altered by dust deposition, salinity of gravel fill used in construction, snow drifts, and blockage of or change to natural drainage patterns. These impacts would be also be long-term and would impact about 10,178 acres, or 0.2% of the planning area.

It is assumed that impacts to wetland communities would occur in proportion to their occurrence within the planning area. However, increased development in the area around Teshekpuk Lake, which would be allowed under Alternative B, could disproportionately impact wetland vegetation classes. A higher percentage of wet vegetation communities occur in areas in the northern portion of the planning area. This area is also considered to have the highest potential for oil reserves, which would increase the likelihood that these areas would be developed under Alternative B.

Impacts to vegetation from non-oil and gas activities, and from oil and gas activities, would likely be additive, except in those areas where the two types of activities overlapped. Impacts to vegetation from exploration and development activities would also be additive, except where development activities occurred in areas previously disturbed during exploration. In areas where two or more activities occurred, overall impacts would reflect those impacts associated with the first activity and any new impacts associated with later activities.

4.4.7 Fish

4.4.7-a Freshwater and Anadromous/Amphidromous Fish

4.4.7-a.1 Activities Not Associated With Oil and Gas Exploration and Development

It is expected that the frequency and intensity of most non-oil and gas activities occurring under Alternative B would be similar to those occurring under Alternative A. Ground camps in support of research may increase in association with the projected increase in oil and gas activity under Alternative B, and subsistence fishing could potentially occur in more areas due to increased access. However, additional impacts to fish from this increase would likely be small.

4.4.7-a.2 Oil and Gas Exploration and Development Activities

Effects of Disturbances

Effects from Seismic Surveys. Potential threats to overwintering fish from seismic surveys in the planning area would include 1) physical damage or acute mortality from acoustic energy pulses; 2) stress associated with acoustic energy pulses; and 3) physical damage to overwintering habitat caused by seismic vehicles. Given that overwintering habitat represents only about 5% of the planning area, it is unlikely that seismic transmissions would occur directly over overwintering sites with any degree of regularity. Overall, any affects to overwintering fish caused by winter seismic surveys would be localized and would not be likely to have any measurable effect on fish populations within the planning area.

Under Alternative B, seismic exploration using Vibroseis in the winter and airgun arrays in the summer would be allowed on Teshekpuk Lake. Impacts under this alternative would be identical to those described for Alternative A.

Under Alternative B, ROP C-2(a) would correspond to Lease Stipulation 24(i, j) of Alternative A, allowing winter ground operations to begin only after the seasonal frost and snow cover are at sufficient depths to protect the tundra, and forcing these operations to cease with the beginning of the spring melt. The exact start and end dates for winter operations would be determined by the AO. While these lease stipulations were designed to protect underlying tundra and vegetation, they would also offer some protection to fish overwintering in pools.

Under Alternative B, ROP C-2(b) would be identical to Lease Stipulation 24(f) of Alternative A by stating that all winter activities must be conducted with low-ground-pressure vehicles. Required Operating Procedure C-4 would be identical to Lease Stipulation 24(e) of Alternative A, requiring that winter stream crossings be located in shallow riffle areas when possible to avoid additional freeze-down of deepwater pools harboring overwintering fish and invertebrates used by fish.

Overall, the general level of protection provided to freshwater, anadromous, and amphidromous fish and fish habitat by ROPs and lease stipulations would be effective and similar for both alternatives. The level of seismic activity would be slightly greater in Alternative B than under Alternative A, but it is expected that any impacts would still be localized. Therefore, it is not

expected that seismic activities occurring under Alternative B would have a measurable effect on fish populations within and adjacent to the planning area.

Effects from Water Demand. Most freshwater bodies less than six feet in depth typically freeze to the bottom. It has been estimated that by late winter ice cover can decrease available freshwater habitat in North Slope rivers and streams by approximately 97% (Craig 1989a). Overwintering areas are therefore limited to deep-water pools and channels in rivers and streams, and to lakes deep enough to provide sufficient under-ice free water during winter. In standing waters, 7 feet is considered the minimum depth for supporting overwintering fish (PAI 2002). Moving waters may deter the thickening of ice, thereby providing overwintering habitat at shallower depths; areas within the Colville River Delta may adequately overwinter fish at depths of 5 feet. Because of the importance of overwintering area to Arctic fish, lease stipulations under all alternatives specifically regulate the winter withdrawal of water from lakes, rivers, and streams.

The principal difference between Alternative B and Alternative A is that under Alternative A, winter water withdrawal from fish-bearing lakes less than seven feet in depth would be prohibited, whereas under Alternative B, withdrawal from fish-bearing lakes (except where ninespine stickleback and/or Alaska blackfish are the only species present) between 5 and 7 feet in depth would be prohibited, but there would be no restrictions on withdrawing water from lakes less than 5 feet in depth.

The only aspect of Alternative B that could decrease protection to freshwater fish, relative to Alternative A, is the 5- to 7-foot provision that is species-specific for ninespine stickleback and Alaska blackfish. The eastern portion of the planning area and Colville River represent the eastern limit of the Alaska blackfish range in northern Alaska, and the presence of this species is occasional throughout the planning area (see **section 3.3.4.2, *Fish Species***). Because of this sparse occurrence, it is possible that Alaska blackfish populations could be negatively impacted. Conversely, ninespine stickleback are very abundant throughout the planning area and the loss of a few fish from a single overwintering site would have a minor effect the population.

Under Alternative B, greater levels of water withdrawal would be expected, in conjunction with increased exploration and development activities, relative to Alternative A. However, careful adherence to lease stipulations and ROPs should help mitigate impacts to fish. Although Alternative B would offer slightly less protection to ninespine stickleback and Alaska blackfish than Alternative A, the net affect to these species would be minor. Therefore, winter water withdrawal would not be expected to have a measurable effect on fish populations in and adjacent to the planning area.

Effects from Exploratory Drilling. Drilling operations require large amounts of water for blending into drilling muds, and also produce large amounts of rock cuttings. If an exploratory well were to be abandoned, drilling muds and cuttings would be re-injected into the bore hole. If the well were to go into production, muds and cutting would be removed to an approved disposal site at Prudhoe Bay. Any chemical leaching into surrounding waters by cuttings temporarily being stored at the drill site could affect nearby fish habitat.

Under Alternative B, Lease Stipulation D-1 would correspond to Lease Stipulation 28 of Alternative A. Both prohibit exploratory drilling in rivers and streams, as determined by the highest high-water mark, and in fish-bearing lakes unless the lessee demonstrates, on site-specific basis, that biological impacts would be minor or there is no other feasible alternative. The number of exploratory wells would be greater under Alternative B than under Alternative

A, but the prohibition of drilling in rivers and streams should minimize impacts to fish. In general, it is not expected that exploratory drilling would have a measurable effect on fish populations in and adjacent to the planning area under Alternative B.

Effects from Gravel Extraction. In general, gravel extraction within the planning area would not likely have a substantially harmful effect on fish overwintering and spawning grounds, since those habitats represent only a small (less than 5%) portion of the planning area. However, if gravel mining activities were conducted in these sensitive areas, the localized impacts could be substantial, possibly resulting in spawning failure and high mortalities of overwintering fish. Other detrimental affects that could occur during the open-water summer season include the blocking and rerouting of stream channels; and increased silt concentrations resulting in reduced primary production, loss of invertebrate prey species, and disruption of feeding patterns for sight-dependent feeders (USDOI BLM 1989). Because gravel spawning areas are limited within the planning area, there may be an association between these sites and optimal gravel extraction sites, increasing the probability that spawning grounds could be impacted.

Under Alternative B, ROP E-8 would correspond to Lease Stipulation 40 of Alternative A. Both are intended to effectively minimize the effects of gravel mining on fish by limiting gravel mine sites within the active floodplain of any river, stream, or lake unless the action enhances fish habitat. The protection provided to fish and fish habitat under Alternative B would be equivalent to that provided under Alternative A. Gravel removal under either alternative is not expected to have a measurable effect on fish populations in and adjacent to the planning area, and gravel removal under both alternatives could have a positive effect by creating new overwintering areas.

Effects from Pad, Road, and Pipeline Construction. Improper placement and construction of drill pads, roadways, pipelines, bridges, and culverts could affect fish and fish habitat by eliminating, diverting, or otherwise impeding flow from small tributaries that connect rivers, streams, and lakes. Altering water flow characteristics could interfere with fish migrations to and from overwintering, spawning, and feeding grounds. Obstructions to fish movement are most common when culverts or low water crossings are not properly sized to allow for the passage of fish during these critical migration periods (Elliott 1982). Movement can be obstructed during periods of either high or low stream flow. Impacts from culverts can be long-lived (beyond the construction phase) if design and placement are not adequate. Recent investigations into stream crossing structures in the North Slope Oilfields found a number of crossings had problems that likely impair or impede fish passage beyond the structures (Morris and Winters 2004, 2007). Obstruction to stream and river flow and fish migrations may also occur if ice bridges are still in place once spring breakup begins.

Under Alternative B, Lease Stipulation E-2 would correspond to Lease Stipulation 41 of Alternative A. Under Alternative A, however, construction of all permanent oil and gas facilities, roadways, airstrips, and pipelines would be prohibited within 500 feet of any active floodplain unless otherwise permitted by the AO (special habitat zones identified in Lease Stipulation 39 have their own designated restrictions), while under Alternative B construction would be prohibited within 500 feet of fish-bearing and 100 feet of non-fish-bearing water bodies (special habitat zones identified in the "K" lease stipulations have their own designated restrictions). Since the only difference between the two alternatives is the size of the buffer zone around water bodies that do not contain fish, both alternatives would afford similar protection to fish and fish habitat.

Under Alternative B, ROP C-3 would be identical to Lease Stipulation 24(d) of Alternative A, which requires that ice bridges be removed or breached before spring breakup to maintain natural flow characteristics of the region. In addition, ROP E-6 would be identical to Lease Stipulation 42 of Alternative A, which states that bridges, rather than culverts, be used for road crossings on all major rivers, and that any culverts necessary on smaller streams be large enough to avoid restricting fish passage or affecting natural stream flow.

Under Alternative B, ROP E-12 would correspond to Lease Stipulation 46 of Alternative A. Both require extensive ecological mapping of proposed development sites in order to access and minimize impacts to sensitive wildlife and fish habitats.

Under Alternative B, any increase in the number of pads, roads, and pipelines constructed, relative to Alternative A, would depend on the amount of recoverable oil and gas reserves that would eventually be brought into production. Rigorous adherence to pre-development environmental assessment, structure siting, and construction codes should minimize impacts to fish. For this reason, as well as those outlined in **section 4.3.7, *Fish*** for Alternative A, construction and placement of drill pads, roadways, pipelines, bridges, and culverts would have only a minor effect on freshwater, anadromous, or amphidromous fish populations in and adjacent to the planning area.

Effects from Summer Tundra Travel. In Alternative A, summer tundra travel is allowed in Northeast NPR-A only through use of the stipulation exception process (see stipulation 24i in the 1998 Northeast NPR-A ROD). Travel off of gravel pads is easiest in winter and generally environmentally preferable at that time, but some vehicle travel off of pads does occur in North Slope oil fields during summer to accomplish specific tasks. The State of Alaska has approved some low-ground-pressure vehicles for summer tundra travel and similar summer tundra travel may be anticipated to be part of oil development in northeast NPR-A. In Alternative B, Required Operating Procedure L-1 was crafted to address summer tundra travel with the following objective: “Protect stream banks and water quality; maintain populations of, and adequate habitat for birds, fish, and caribou and other terrestrial mammals; and support maintenance of subsistence activities.” Summer tundra travel is commonly associated with spill prevention and preparedness measures required in spill prevention plans and it is anticipated that these are the types of activities that would be permitted to travel off of gravel pads and roads during times other than those identified in ROP C-2a if required surveys and studies show that minimal impacts to the resources in the area would occur.

The potential impacts on fish related to summer tundra travel include sedimentation and degraded water quality. If vehicles cross streams, increased sedimentation could occur from streambank damage and disturbance of the streambed, and small leaks from equipment (e.g. fuel or mechanical fluids) could degrade water quality. However, stream crossings would likely be rare and only approved by the AO if the L-1 ROP objective can be met, which aims to protect stream banks and water quality. If a stream crossing was allowed, a short-lived sediment pulse from disturbing the streambed would have a very short-lived effect on the stream. Any accidental small leak from a vehicle would not have a discernible impact on fish. Because of protection to fish habitat provided by the L-1 ROP in Alternative B, summer tundra travel would not have a measurable effect on freshwater, anadromous, or amphidromous fish populations within and adjacent to the planning area.

Effects from Causeways. The construction of solid gravel causeways along the coast has long been a sensitive fisheries issue (USACE 1980, 1984). These structures, which can extend several miles out to sea, are used for offshore drilling, year-round seawater extraction, and as

docking facilities for sea-born supply. Their solid construction enables them to withstand the immense pressures of shifting coastal ice in late winter and spring. They also have the potential to physically block fish moving along the shore and/or alter coastal circulation and mixing patterns such that hydrographic conditions becomes inhospitable for anadromous and amphidromous fishes. The nearshore coastal zone is a prime summer feeding ground for these species. Studies conducted at Prudhoe Bay have documented some instances in which causeways have indeed altered, impeded, and even completely blocked anadromous and amphidromous fish from migrating along the coast (Fechhelm 1999; Fechhelm et al. 1989, 1999).Under Alternative B, Lease Stipulation E-3 would be virtually identical to Lease Stipulation 30 of Alternative A. Both prohibit the construction of causeways, docks, artificial gravel islands, and bottom-founded structures in river mouths and deltas, and artificial gravel islands and bottom-founded structures in active stream channels, unless otherwise approved by the AO on a site-specific basis. Any approved structures must be designed, sited, and constructed in a way to prevent substantial changes in nearshore hydrography, and must maintain free passage of marine, anadromous, and amphidromous fishes. Active monitoring at these structures could also be required. Given these restrictions, the future construction of a causeway or dock could have a minor effect on anadromous, and amphidromous fish populations under Alternative B.

Effects from Waterflooding. As under Alternative A, oil fields in the northern portion of the planning area would likely receive seawater from facilities already serving fields in the Prudhoe Bay/Kuparuk area under Alternative B. These facilities, which have been operational for years, and have been shown to have only a minor effect on fish migrating or foraging in the intake area. If seawater intake facilities were constructed in the future to enhance supply to oil fields in the planning area, it is assumed that the same design safeguards would be incorporated to prevent the entrainment and impingement of fish. Therefore, under Alternative B, waterflooding would not be expected to have a measurable effect on anadromous and amphidromous fish, regardless of any increase in exploration and development activities.

Effects of Abandonment and Rehabilitation

Water withdrawal and removal of bridges, culverts, and bridge approaches could have impacts on fish similar to those described for construction activities. Additional fish habitat could be created by allowing gravel pits to be colonized by fish from nearby streams. Because more infrastructure will be potentially developed under Alternative B, it is anticipated that the impacts of abandonment and rehabilitation will be greater under this alternative than under Alternative A.

Effects of Spills

Oil spills have been observed to have a range of effects on fish (Malins 1977; Hamilton et al. 1979; Starr et al. 1981). The specific effect depends on the concentration of petroleum present, the length of exposure, and the stage of fish development involved (eggs, larva, and juveniles are most sensitive). If lethal concentrations are encountered (or sub-lethal concentrations over a long enough period), fish mortality is likely to occur. However, mortality caused by a petroleum-related spill is seldom observed outside the laboratory environment. Most acute-toxicity values (96-hour lethal concentration for 50% of test organisms [LC_{50}]) for fish generally are on the order of 1 to 10 ppm. Concentrations measured under the slicks of oil spills at sea have been less than the acute values for fish and plankton. For example, concentrations of oil 1.6 to 3.3 feet beneath a slick from the Tsesis spill (Kineman et al. 1980) ranged from 50 to 60 parts-per-billion (ppb). Extensive sampling following the Exxon Valdez oil spill (about 260,000

bbl in size) also found hydrocarbon levels that were well below those known to be toxic or to cause sub-lethal effects in plankton (Neff 1991). The low concentration of hydrocarbons in the water column following even a large oil spill at sea appears to be the primary reason for the lack of lethal effects on fish and plankton.

Most of the ROPs and lease stipulations associated with Alternative B that are designed to prevent or otherwise deal with oil spills in the planning area are the same as the lease stipulations listed for Alternative A. Under Alternative B, these include ROPs A-2(d), A-3, A-4, A-6, A-7(a), and E-4. Under Alternative B, ROP A-5 would correspond to Lease Stipulations 15 and 16 of Alternative A. Whereas Lease Stipulation 16 prohibits refueling within 500 feet of any water body or in any active flood plain (fueling of boats, float planes, and ski planes permitted), ROP A-5 prohibits refueling within 500 feet of fish-bearing and 100 feet of non-fish-bearing waterbodies (fueling of boats, float panes, and ski planes permitted). Small caches of boat or plane fuel are permitted in the restricted areas under both alternatives. The buffer zone can be reduced from 500 to 100 feet if it can be demonstrated that those bodies do not contain fish. Both alternatives would mitigate impacts to surrounding fish and fish habitat. Lease Stipulation 15 of Alternative A prohibits the storage of fuel on any active floodplain, whereas that decision is left up to the AO under Alternative B. With proper safety features, impacts to fish and their habitat would be minimized under both alternatives.

Under Alternative B, the volume of spills and expected amount of impact would increase proportionately (from Alternative A) with increased exploration and development. In Alternative B, the volume of oil from small and large spills is projected to be 12% more than the volume from spills estimated to occur under Alternative A. Given the small volume of oil typically involved in small spills, as well as the safety requirements for operations in the oil field and stringent clean-up protocols, small oil spills associated with Alternative B would not likely have a measurable effect on freshwater, anadromous, or amphidromous fish populations in or adjacent to the planning area. Besides the effectiveness of the response, many independent factors will determine the probability that fish will be negatively impacted by an oil spill, including the quantity spilled, season, weather patterns, location (e.g. upland versus river channel), and proximity to sensitive habitat (see **section 4.2.2.3, *Fate and Behavior of Spilled Oil***). If a large spill of crude oil occurred during the summer open-water period and within a major stream or river channel, this could potentially have an effect on freshwater, anadromous, or amphidromous fish populations in or adjacent to the planning area; in particular, impacting subpopulations at the drainage level. A very large oil spill within a major stream or river channel during the summer would have an even more likely impact on freshwater, anadromous, or amphidromous fish populations in or adjacent to the planning area.

Commercial Gas Development

Impacts of commercial gas development under Alternative B would be similar to that described for Alternative A. Winter construction of a buried gas pipeline by trenching through fish inhabited streams or portions of streams not frozen to the bottom would impact fish to some degree, depending on the volume of the overwintering habitat and the density of fish utilizing this habitat. Potential impacts to fish associated with maintenance of gas pipelines would be similar to those described for construction. Water withdrawals and changes to hydrology caused by ice roads could affect fish. Potential issues include losing access to suitable habitat, barriers to movement, or habitat degradation. These ice roads would be necessary during both natural gas exploration and construction phases. For example, ice roads would be used to reach exploration drilling sites and also used in trenching the pipeline route or construction of a compressor station. (ADNR, 2006b). If a buried gas pipeline ruptured and gas escaped to a

fish-bearing waterbody, some fish in the immediate vicinity might be killed. Natural gas and condensates would be hazardous to any organisms exposed to high concentrations. In general, very few fish are likely to be affected by a pipeline rupture.

While natural gas exploration and development may have notable localized impacts, it is not likely to have a measurable effect on freshwater fish populations.

4.4.7-a.3 Effectiveness of Stipulations and Required Operating Procedures

As noted above, numerous performance-based lease stipulations and ROPs are proposed under Alternative B to protect fish and their habitats. As discussed, these lease stipulations and ROPs afford similar protection to fish as lease stipulations developed for Alternative A.

4.4.7-a.4 Conclusion

The potential impacts to freshwater, anadromous, and amphidromous fish from oil exploration and development activities within the planning area under Alternative B would be greater than potential impacts for Alternative A and include minor impacts to sensitive overwintering habitats from winter seismic activities; loss of overwintering habitat from water withdrawals; degradation or blockage of water bodies used as fish migratory corridors or feeding grounds resulting from the construction and placement of pipelines, pads, ice and gravel roadways, airstrips, and causeways; loss or degradation of habitat from gravel extraction; crude and refined-oil spills; and loss or degradation of habitat from gravel structure erosion.

Activities proposed under Alternative B should have only minor effects on fish and their habitats. By opening up additional lands near Teshekpuk Lake to leasing, fish in this lake and other deep-water lakes and streams would have a greater potential to be impacted by spills and habitat degradation, resulting in greater risks to fish under this alternative than Alternative A. Performance-based ROPs and lease stipulations developed for this alternative, however, would ensure the exploration and development activities are designed to effectively minimize impacts to fish habitats and that procedures are in place to clean up most spills before they can harm fish or their habitats. The threat of localized impacts affecting fish stocks would increase if they occurred in sensitive habitats.

In general, impacts to fish from non-oil and gas activities, and from oil and gas activities, would likely be additive, except in those areas where the two types of activities overlapped. Impacts to fish from exploration and development activities would also be additive, except where development activities occurred in areas previously disturbed during exploration. However, once exploration and development/production ceased in an area, fish populations and habitat could recover, reducing overall effects in the planning area. Because of the larger disturbance area and potential for more oil and gas exploration and development activities, the potential for impacts to fish under this alternative would be about two times greater for oil and gas exploration activities, and four times greater for oil development activities, as compared to Alternative A.

4.4.7-b Marine Fish

4.4.7-b.1 Activities Not Associated With Oil and Gas Exploration and Development

Most non-oil and gas ground activities would be quite limited in scope and duration. In addition, recreational and commercial fishermen do not target marine fish in the Beaufort Sea. Therefore, it is not expected that non-oil and gas activities occurring under Alternative B would have a measurable effect on marine fish in the vicinity of the planning area.

4.4.7-b.2 Oil and Gas Exploration and Development Activities

Effects of Disturbances

Effects from Seismic Surveys. Seismic surveys would be conducted within the planning area during the winter months, from early December to mid-May, and possibly during the summer on Teshekpuk Lake. Because marine fish and their habitat lie outside the planning area in winter and Teshekpuk Lake in summer, seismic activities associated with Alternative B would not be expected to have a measurable effect on marine fish populations.

Effects from Water Demand. Water used in the building of drill pads, roads, and airstrips would likely be withdrawn from freshwater sources near the site of construction. These activities would have no effect on marine fish and their habitat. Water withdrawal for the purposes of waterflooding, which would have implications for the marine system, is discussed separately below under the "Effects from Waterflooding" subheading.

Effects from Exploratory Drilling. Most exploratory drilling would be conducted within the planning area during the winter months, from early December to mid-April. Because marine fish and their habitat lie outside the planning area in winter, most exploratory activities associated with Alternative B would not be expected to have a measurable effect on marine fish populations. Exploratory drilling could also be conducted from current production pads or platforms within a lake body during summer in the TLCH Area, but impacts to marine fish would be minor.

Effects from Gravel Extraction. It is doubtful that gravel extraction would be permitted along the coastal tidal zone. Small numbers of fourhorn sculpin and Arctic flounder could migrate upriver in summer, but any encounter with a gravel site would be a chance occurrence, and would involve only a minuscule segment of any population. Fourhorn sculpin and Arctic flounder regularly inhabit and forage in highly turbid coastal waters near river outfalls and plumes. Gravel extraction would not benefit fish populations by creating overwintering habitat, as it might for freshwater fish, since all marine fish overwinter at sea.

Under Alternative B, ROP E-8 would correspond to Lease Stipulation 40 of Alternative A. Both are intended to effectively minimize the effects of gravel mining on fish by limiting gravel mine sites within the active floodplain of any river, stream, or lake unless the AO determined that there was no other alternative or that the site would ultimately enhance fish habitat.

Effects from Pad, Road, and Pipeline Construction. Pad, road, and pipeline construction would largely be limited to freshwater habitat regions of the planning area, and would not establish a footprint in marine or coastal habitats. Under Alternative B, Lease Stipulation K-6

requires that all permanent oil and gas facilities, including gravel pads, roads, airstrips, and pipelines established to support exploration and development activities, be located at least ¾ mile inland from the coastline to the extent practicable. The use of previously occupied coastal sites such as Camp Lonely and DEW-Line sites, or sites within ¾ mile of the coastline if an exception is granted by the AO, is possible. Future exceptions could be the construction of docking facilities along the coast, although, for the near future, sea borne re-supply would likely involve the already operational docking facilities at West Dock. A similar level of protection for the coastline would not be provided under Alternative A.

Required Operating Procedure E-12 requires extensive ecological mapping of proposed development sites in order to access and minimize impacts to sensitive wildlife and fish habitats. All coastal construction would be approached with environmental caution. This lease stipulation is similar to Lease Stipulation 46 for Alternative A.

Effects from Causeways. The construction of solid gravel causeways along the coast is less of an issue for marine fish than it is for anadromous and amphidromous fish. The major migration for two of the most dominant species, fourhorn sculpin and Arctic flounder, is onshore soon after ice breakup. Once in coastal waters, these sedentary species do not undergo the extensive alongshore migrations up and down the coast that are characteristic of Arctic cisco and the amphidromous species. Potential blockage to alongshore movement is less critical.

Under Alternative B, Lease Stipulation E-3 would provide restrictions on the use, design, and monitoring of causeways that might be constructed along the coast in the future, although Lease Stipulation 30 of Alternative A entails greater protective and regulatory measures to mitigate impacts to marine fish.

Effects from Waterflooding. Under Alternative B, waterflooding would not be expected to have a measurable effect on marine fish for the reasons given in Alternative A.

Effects of Spills

Hydrocarbon spills can impact marine fishes of any life history stage. Such impacts may include sublethal and/or lethal effects. The intensity of the effects upon a marine fish population or assemblage of species is dependent on a suite of dynamic factors. The size of the spill does not necessarily directly relate to the number of individuals that could be impacted.

The threat to marine fish from an oil spill is contingent upon the spill reaching coastal waters at volumes capable of affecting large nearshore areas. Because oil spills in the planning area are expected to be small, and given the stringent oil-spill-response safety requirements for operations on the oil field, there is a minor likelihood that an inland spill would reach coastal/marine waters of the planning area at volumes capable of causing a biologically important or measurable impact to marine fishes.

Lease Stipulation K-6 requires that all permanent oil and gas facilities, including gravel pads, roads, airstrips, and pipelines, be located at least ¾ mile inland from the coastline, to the extent practicable. Because oil spills in the planning area would likely be small, and given the stringent and effective oil-spill-response safety requirements for operations on the oil field as identified in ROPs A-2(d), A-3, A-4, A-5, A-6, A-7(a), and E-4, and the setback restrictions of Lease Stipulation K-6, a major oil spill in the marine environment would be unlikely.

The primary difference in the regulations of Alternative A and Alternative B is the way in which wastewater discharges may be disposed of in the marine environment. Under Alternative B, ROP A-7(a) allows for the disposal of these waters in the marine environment at the discretion of the AO, based on a case-by-case review of environmental factors and consistency with NPDES regulations. In comparison, Lease Stipulation 5(d) of Alternative A allows for a case-by-case approval for discharge into marine waters greater than 33 feet deep, but expressly forbids discharge into marine water shallower than 33 feet. Given that the AO would undertake a rigorous environmental review and take the necessary precautionary measures to ensure the biological and environmental integrity of marine waters, marine fish should be equally protected under Alternative B and Alternative A.

The number of spills that would occur under Alternative B is estimated to be four times greater than the number of spills predicted to occur under Alternative A, and these spills would be dispersed throughout the mainland planning area. Therefore, impacts from spills would be greater under Alternative B than Alternative A.

Commercial Gas Development

Marine fish populations are not expected to be affected by exploration, construction, or maintenance activities associated with a gas development beyond what is expected to occur during oil development.

4.4.7-b.3 Effectiveness of Stipulations and Required Operating Procedures

As noted above, prescriptive- and performance-based lease stipulations proposed under Alternative A and Alternative B offer similar protections to fish and their habitats. Lease Stipulation K-6 developed for Alternative B, however, specifically prohibits permanent oil and gas development within ¾ mile inland from the coastline, unless the AO grants an exception; similar protection is not provided under Alternative A. Thus, greater protection is afforded marine fish under Alternative B than Alternative A.

4.4.7-b.4 Conclusion

In general, marine fish of the Beaufort Sea are insulated from many potential environmental impacts associated with oil and gas development in the planning area. Most of the coastal tidal area of the planning area is shallow and lies within the winter landfast ice scour zone. Thus, the marine habitat and the fish occupying it are outside the planning area proper during winter and would not be subject to disturbances associated with winter seismic surveys, exploration drilling, and water withdrawal. Although species like fourhorn sculpin and Arctic flounder may move upriver during summer, most members of these marine species remain in shallow coastal waters and would not be impacted by summer seismic surveys in Teshekpuk Lake or exploratory drilling in lakes in the TLCH Area. The bulk of the marine fish population would not be directly subject to the effects of river gravel extraction, pad, road, and pipeline construction, sedimentation from gravel erosion, and the potential blockage of migratory corridors.

Because marine species are abundant and widely distributed throughout the Beaufort Sea, it is also highly unlikely that any point impact associated with oil and gas development in the planning area (the occurrence of which is unlikely) would have a substantial impact on these species at the population level. One exception might be a catastrophic oil spill that could cause sublethal genetic or physiological abnormalities that might be propagated through the broader

population. However, given that oil spills in the planning area are expected to be small, and the stringent oil-spill-response safety requirements for operations on the oil field, such an event is unlikely.

Overall, it is not expected that oil exploration and development activities under Alternative B would have a measurable effect on marine fish populations in or adjacent to the planning area. Implementation of Lease Stipulation K-6 would afford marine fish protection under Alternative B that would not be provided under Alternative A. Impacts to marine fish resources under Alternative B would be similar to, or slightly greater than, those that could occur under Alternative A.

4.4.8 Birds

This section discusses the potential effects to bird species, which are not threatened or endangered, that could result from management action in the planning area under Alternative B. A discussion of effects to threatened and endangered bird species is given in **section 4.4.10, *Threatened and Endangered Species***. Most of the activities that could potentially affect birds in the planning area would result from oil and gas exploration and development. Other activities that could potentially affect birds in the planning area include subsistence activities (including hunting, fishing, berry picking etc.), recreational use, activities associated with scientific surveys and research camps, clean up of old oil and gas exploration sites, and activities associated with government actions (e.g. clean up of abandoned well sites). These activities could affect tundra nesting birds by causing: 1) temporary or permanent habitat loss; 2) various types of disturbance related to equipment and facility noise, vehicular and air traffic, and pedestrian activities, which could result in displacement from preferred foraging, staging, nesting and/or brood-rearing habitats or decreasing productivity and survival; 3) increased predation from predators attracted to areas of human activity; and 4) mortality resulting from collisions with vehicles or structures, or exposure to contaminants, including oil spills. Alternative B would make available approximately 95% (4,387,000 acres) of the planning area's approximately 4.6 million acres for oil and gas leasing (Map 2-2). Management practices would emphasize performance-based stipulations and ROPs on surface activities, consultation with local residents, and coordinated scientific studies to protect wildlife habitat, subsistence use areas, and other resources. In addition, approximately 213,000 acres would be unavailable for oil and gas leasing, to provide for protection of wildlife and subsistence resources.

4.4.8.1 Activities Not Associated With Oil and Gas Exploration and Development

Under Alternative B, activities not related to oil and gas exploration and development that could affect birds in the planning area would be the same as those described under Alternative A: private or commercial air traffic; aerial surveys to inventory wildlife or other resources; summer research camps; hazardous material or debris removal; subsistence hunting and fishing; and recreational camps and boating activity. As compared to Alternative A, impacts to birds from non-oil and gas activities could be more frequent, greater in extent, or longer in duration under Alternative B. A greater number of individual animals would likely be exposed to human activities. Aircraft traffic would more often pass overhead of birds during flights to or from the camps and along aerial survey routes. The disturbance reactions of birds would likely be brief, lasting for a few minutes to an hour. Some birds might avoid inventory survey and recreation camps during the 6 to 12 weeks of activities, while some birds (e.g. ravens) could be attracted to the camps. Lease stipulations and ROPs to protect waterfowl, shorebirds, raptors,

and other birds and their habitats would help to mitigate the potential effects of non-oil and gas activities on birds under Alternative B.

4.4.8.2 Oil and Gas Exploration and Development Activities

Effects of Disturbances

Exploration

Most seismic surveys to collect geological data and exploration drilling activities would occur during the winter months when birds are mostly absent from the planning area. Under Alternative B, the types of effects of winter exploration activities on the bird species present that would be in the planning area during the winter would be the same as those discussed under Alternative A. Although impacts associated with winter exploration would likely be minor under either alternative, there could be a slightly greater effect to birds under Alternative B because areas of greater bird habitat value would be available for exploration than under Alternative A, it is expected that the same number of seismic surveys will occur under all alternatives (see **section 4.2.1.2**). The direct effects of exploration would likely include the temporary displacement of a small number of birds (ptarmigan and gyrfalcons) from preferred winter feeding or roosting areas.

During winter exploration activities, indirect impacts to birds could result from the construction of ice-roads and ice-pads and the associated water withdrawal. The types of effects that could result from ice-road and ice-pad construction under Alternative B would be the same as those described under Alternative A, and would primarily involve the temporary alteration of tundra habitats. Water withdrawal for ice-road construction could also temporarily alter habitats adjacent to water source lakes, which could affect nesting or brood-rearing loons and waterfowl. Rolligons and track vehicles used during winter exploration could also temporarily affect tundra vegetation, resulting in minor impacts to tundra-nesting birds. A larger area would be available to oil and gas exploration activities under Alternative B, as compared to Alternative A. Therefore, the potential impacts to birds resulting from exploratory activities would also likely be greater under Alternative B. Primarily; there would likely be additional effects to birds in the areas surrounding the portion of the Goose Molting Area that would be open to leasing under Alternative B, but not under Alternative A. However, Lease Stipulation K-4 may mitigate some potential impacts in the Goose Molting Area by prohibiting water extraction and other oil and gas activities that could affect goose feeding habitat along lakeshore margins. Currently there is little known as to why geese use the Goose Molting Area in such large concentrations and impacts to vegetation or impoundments and delayed drainage due to ice roads may have a negative effect on the habitat used by molting geese.

The use of airguns for boat-based seismic work in Teshekpuk Lake during the summer could temporarily displace loons and waterfowl from preferred feeding habitats while surveys were being conducted. Disturbance may result not only from airgun use but also from boat activity (Rodgers and Smith 1995). Because setbacks around the perimeter of the lake presumably would eliminate the potential for disturbance to birds nesting near the lakeshore, only birds using habitats in the open water of the lake would potentially be disturbed. Birds displaced by seismic activities would likely return to preferred habitats after the airgun arrays passed through the area. Effects of use of airguns on forage fish may include stress from fleeing behavior and physical damage or death (**section 4.1.1** this document) potentially resulting in a reduction in the amount of prey available to foraging loons. Disturbance to birds near and nesting on the shoreline could result from support activities, such as use of helicopters to

transport personnel and supplies. Disturbance related to support activities could result in permanent or temporary displacement from nesting, feeding, or brood-rearing habitats. Conducting surveys after the completion of the nesting and brood-rearing period would eliminate the potential for nest abandonment and loss of productivity.

Predators, such as glaucous gulls, ravens, and Arctic foxes, could be attracted to anthropogenic food sources associated with summer maintenance of exploratory drilling and seismic equipment or winter exploratory activities. Under Alternative B, the potential effects of increased predation would be mitigated by ROPs A-2 and E-9, and the overall effects to birds would likely be similar under Alternative A and Alternative B. Although Alternative A would not have a provision similar to ROP E-9, which requires the lessee to utilize the best available technology to prevent facilities from providing nesting, denning, or shelter sites for ravens, raptors, and foxes, this lease stipulation may not be particularly relevant to the temporary storage of exploratory drilling and seismic equipment.

Oil and Gas Development

Activities on Roads and Pads. Activities related to oil development and production in the planning area, such as vehicle, aircraft, pedestrian, and boat traffic; routine maintenance activities; heavy equipment use; and oil-spill clean-up activities could cause disturbances that would affect tundra-nesting birds. Under Alternative B, these types of disturbances to birds would be the same as those discussed under Alternative A. These disturbances could result in temporary displacement from preferred foraging, nesting, molting, staging and/or brood-rearing habitats; decreased nest attendance or nest abandonment; and increased energy expenditures that could affect physiological condition, rate of survival, and productivity of birds. The likelihood for impacts to tundra-nesting birds would depend on the location of the disturbance, the bird species and the number of individuals in the area, and the time of year. The greatest potential for impacts from disturbance would most likely occur in habitats with high bird concentrations, such as the Teshekpuk Lake Goose Molting Area, or if species with low or declining populations, such as buff-breasted sandpiper or yellow-billed loon, were disturbed.

The potential for disturbance to birds from activities on roads and pads would likely be greater under Alternative B, as compared to Alternative A, because there are areas that support high bird concentrations in portions of the Goose Molting Area that would be available for oil and gas leasing under Alternative B, but not under Alternative A. The reduction in the amount of habitat protected under Alternative B, as compared to Alternative A, would likely increase the risk of disturbance to internationally significant populations of molting geese, particularly brant that use the Goose Molting Area. The reduction in protection under Alternative B could also affect white-fronted, lesser snow and Canada geese. Disturbance that resulted in a reduction in the breeding success of geese and other waterfowl could also impact the success of subsistence and sport hunters in Alaska, the lower 48 states, Canada, Russia, and Mexico. Disturbance effects could also impact shorebirds if development occurred in areas of high shorebird concentration located north of Teshekpuk Lake. Lease Stipulation K-4, however, would help to mitigate potential disturbance to birds in the Goose Molting Area, by providing setbacks from goose molting lakes within which permanent oil and gas facilities would be prohibited. Lease Stipulation K-4 would also reduce impacts to goose molting lakes by preventing excessive water extraction activities; provide for protection of shoreline habitats adjacent to these lakes; and help mitigate disturbance near goose molting lakes from oil and gas activities by requiring features that would screen or shield human activity from the view of any goose molting lake, and by minimizing ground traffic from May 20 through August 20. Lease Stipulation K-4 would permit the construction of facilities, such as platforms, on lakes within ¾ mile of the lake shore,

which could increase disturbance to molting geese if platforms were constructed on lakes used by molting geese. Lease Stipulation K-6 would establish a ¾-mile buffer inland from the coast, within which oil and gas facilities would be prohibited, to the extent practicable, to minimize hindrance or alteration of caribou movement within caribou coastal insect-relief areas. This lease stipulation could also help to reduce the potential impacts to waterfowl and their habitats in coastal areas.

Under Alternative B, there could be disturbance to birds in a 5 to 6 mile wide band south and west of Teshekpuk Lake that would be open to surface activity under Alternative B, but closed under Alternative A. Lease Stipulation K-5, designed to protect the Teshekpuk Lake Caribou Habitat Area, would help to mitigate potential disturbance effects to birds by placing limits on various types of oil and gas exploration and development activities that could occur on roads and pads from May 20 through August 20.

Under Alternative A, no permanent oil and gas facilities would be permitted within ¼ mile of the perimeter of any fish-bearing lake in the Deep Water Lakes Area south of Teshekpuk Lake. Under Alternative B, facilities would generally not be permitted within this buffer, but could be permitted, on a case by case basis, in consultation with Federal, state, and NSB regulatory and resource agencies. Permitting facilities within the ¼-mile buffer of fish-bearing lakes in the Deep Water Lakes Area could result in disturbance to yellow-billed loons and waterfowl near the facilities and access roads. However, other bird groups could also be disturbed if facilities were located outside the ¼-mile buffer. The extent of effects to birds from activities on roads and pads would depend on the species and numbers of individuals occurring in areas adjacent to the development. Although Lease Stipulation K-2 has been designed primarily to provide mitigation for deepwater fish habitat, it would also be likely to reduce disturbance of birds using habitats near these lakes.

Summer Tundra Travel. Alternative A allows summer tundra travel in Northeast NPR-A only through use of the stipulation exception process (see stipulation 24i in the 1998 Northeast NPR-A ROD). Travel off of gravel pads is easiest in winter and generally environmentally preferable at that time, some vehicle travel off of pads does occur in North Slope oil fields during summer to accomplish specific tasks. The State of Alaska has approved some low-ground-pressure vehicles for summer tundra travel and similar summer tundra travel may be anticipated to be part of oil development in northeast NPR-A. Alternative B contains Required Operating Procedure L-1 which was crafted with the following objective "Protect stream banks and water quality;...maintain populations of, and adequate habitat for birds, fish, and caribou and other terrestrial mammals; and support maintenance of subsistence activities." Summer tundra travel is commonly associated with spill prevention and preparedness measures required in spill prevention plans and it is anticipated that these are the types of activities that would be permitted to travel off of gravel pads and roads during times other than those identified in ROP C-2a if required surveys and studies show that minimal impacts to the resources in the area would occur. The potential for disturbance to birds from summer tundra travel would likely be greater under Alternative B, as compared to Alternative A, because there are areas that support high bird concentrations in portions of the Goose Molting Area that would be available for oil and gas leasing under Alternative B, but not under Alternative A. The reduction in the amount of habitat protected under Alternative B, as compared to Alternative A, would likely increase the risk of disturbance to internationally significant populations of molting geese, particularly brant that use the Goose Molting Area. The additional areas available for leasing under Alternative B could also negatively affect white-fronted and Canada geese. Disturbance that resulted in a reduction in the breeding success of geese and other waterfowl could also impact the success of subsistence and sport hunters in Alaska, the lower 48

states, Canada, Russia, and Mexico. Disturbance effects could also impact shorebirds if development occurred in areas of high shorebird concentration located north of Teshekpuk Lake.

Air Traffic. Both fixed-wing aircraft and helicopters could be used to transport personnel, supplies, and equipment to airstrips or staging areas during development and production activities in the planning area. The types of disturbance effects to waterfowl and other bird groups from aircraft would be the same under Alternative B as those discussed under Alternative A, and could include displacement from preferred feeding habitats, temporary or permanent nest abandonment, and temporary or permanent displacement from staging, molting or brood-rearing areas. However, some birds could habituate to aircraft activity and either remain in habitats located near aircraft activities, or move to nearby habitats. This may not be the case for brant, as they apparently do not acclimate well to aircraft traffic (Derksen et al. 1992). Aircraft disturbance to brant may cause behavioral and physiological responses that could increase energy expenditures and reduce foraging time, which could increase the duration of the flightless period and susceptibility to predation. Birds could be displaced from optimal to sub-optimal habitats, causing birds to spend more time foraging to meet nutrient needs (Derksen et al. 1992).

Compared to Alternative A, it is likely that there would be a greater amount of disturbance to birds from aircraft activity under Alternative B, as a greater amount of area would be available for oil and gas leasing in the Goose Molting Area, and from facilities in the portions of the Teshekpuk Lake Caribou Habitat Area (where surface activity would be prohibited under Alternative A). Under the development scenario for Alternative B, the projected number of flights per day may range from 50 to 90 depending on the phase of development. These numbers are based on the number of flights that occurred during the Alpine field development (USDOI BLM 2004C). The effects of aircraft disturbance would likely have moderate effects on waterfowl and shorebirds. Under Alternative B, Lease Stipulations K-3 through K-6 would provide setbacks from various habitats surrounding Teshekpuk Lake and along the coast that are considered important for fish, birds, and caribou. Within these setbacks, permanent oil and gas facilities would be prohibited, and other potentially disturbing activities, such as vehicular and air traffic, would be restricted. These lease stipulations would help to mitigate for potential aircraft disturbance, should oil and gas facilities be located within the Teshekpuk Lake Special Areas. However, if CPFs were located within the Teshekpuk Lake Special Areas, the level of aircraft disturbance would likely increase along flight corridors between oil production facilities and airfields and at airstrips located at these CPFs.

If a CPF were located within the ¼-mile buffer around lakes under Alternative B, there would likely be a greater amount of disturbance to waterfowl in the Deep Water Lakes Area than under Alternative A. The degree of effects to birds would depend on the number of birds present and which species of birds were using habitats near the facility. Although Lease Stipulation K-2 was designed primarily to mitigate potential impacts to fish, this lease stipulation, which would provide for agency consultation prior to development within the ¼-mile buffer, could also help reduce potential impacts to birds.

Watercraft. Several types of watercraft could be used during the summer and fall to transport equipment and supplies and to conduct oil spill response training drills. Summer and fall barge traffic (up to 30 barges per year with each CPF requiring 1 or 2 seasons of barge traffic depending on size), with the potential to temporarily displace feeding, molting, brood-rearing and staging waterfowl, could occur in near shore and offshore waters of the planning area from mid-July through October. These impacts would vary depending on the species of birds using

the area and activity of those birds at the time of the disturbance but are likely be minor. Displaced waterfowl would probably move to adjacent habitats or return to original habitats after the barges passed though the area, and barge traffic would not be expected to substantially impact waterfowl. It is well known (Avery et al. 1980, Springer and Dailey 1980, Day et al. 2003) that birds may be attracted to sources of light with the potential for the bird to strike a structure (building, barge, tower etc.) resulting in the possibility of mortality. There are documented accounts of waterfowl and seabirds being attracted to and colliding with ships in various light conditions (Dick and Donaldson 1978). Eiders in particular are thought to be susceptible to collision with human-made structures because they fly low over the water while migrating, fly rapidly when migrating, and are attracted to lights (Day at al. 2003 and references contained within). However, there is a short window of time during the fall when the planning area is dark and birds are present, thus the potential for collisions between staging waterfowl and barges working in the planning area is low. Effects of barge traffic would vary in intensity depending on the timing, location and duration of the traffic in areas of high bird concentrations. Overall barge traffic in the Arctic Ocean is projected to increase due to the observed longer open water season and retreat of sea-ice in the arctic. However, there is a short window of time during the fall when the planning area is dark and birds are present, thus the potential for collisions between staging waterfowl and barges working in the planning area is low. There would be a greater likelihood for disturbance to waterfowl under Alternative B than under Alternative A, because more area would be available for leasing under Alternative B including areas of high use by waterfowl.

Oil spill response training activities using watercraft could be conducted on rivers and lakes several times during the summer. Disturbance from watercraft activity along rivers could affect birds such as ruddy turnstones, semipalmated plovers, and Baird's sandpipers that use gravel bars. The results of disturbance may include failure to nest or nest abandonment (Rodgers and Smith 1995). Under Alternative B, these activities would be more likely to disturb waterfowl than under Alternative A, because there would be a greater likelihood that facilities would be located in areas of high bird use within the Teshekpuk Lake Special Area.

Habitat Losses and Alteration

Permanent Habitat Loss. Gravel mining and placement for the construction of oil field infrastructure would have the greatest potential to result in the loss of tundra-nesting bird habitat. Under Alternative B, it is estimated that there will be a need for six central processing facilities (90 acres each) in the planning area. In conjunction with these facilities there are other support structures, such as gravel production pads, gravel runways in-field gravel roads, several types of pipelines, and other associated structures, that will also cause surface disturbances. It is estimated that under Alternative B, there will be: 25 gravel production pads (10 acres each); 6 gravel runways (11 acres each); 250 miles of in-field gravel roads (7.75 acres/mile); 250 miles of three-phase produced fluids (oil, gas, water) gathering lines; 162 miles of sales oil pipelines; 6 pump stations (20 acres each); 3 staging bases (50 acres each); and 13 gravel pits (50 acres each). It is estimated that during the construction phase of these facilities that the total short term disturbance would be 4,965 acres. During the production phase it is estimated that the total long term disturbance would be 3,716 acres (Table 4.2-G).

Tundra covered by gravel, as well as tundra associated with gravel mine sites, would be lost as nesting, brood-rearing, and foraging habitat for birds. The potential effects of habitat loss under any alternative would likely have moderate impacts to tundra-nesting birds and would depend on the location of the development, the types of habitat lost, and the level of bird use in the areas to be developed could potentially have greater impact on tundra-nesting birds than under

Alternative A because of the increased amount of habitat loss under Alternative B and because some areas of high bird use that are closed to development under Alternative A would be open to leasing under Alternative B. Permanent habitat loss under Alternative B would likely have less negative impact on birds than Alternatives C and D as greater amounts and more sensitive areas would be available for leasing under Alternatives C and D.

Birds that use drier habitats may be more affected by habitat loss than those that use wet habitats because less dry habitat is available in the NPR-A. Loss of dry habitat could be especially important for buff-breasted sandpiper, which is a species of concern with low population numbers that uses dry habitats. In addition, under Alternative B, there would be an increased potential for birds to be affected by a functional loss of habitat in areas near roads and pads if development-related disturbances precluded birds from utilizing these habitats.

Temporary Habitat Loss. In addition to permanent habitat loss, temporary loss of tundra habitat adjacent to gravel roads and pads could occur as a result of thermokarst, dust deposition, snow accumulation, and impoundment formation. Water withdrawal from lakes during ice-road construction could temporarily affect birds in adjacent habitats if the lakes did not have adequate recharge capabilities. Under Alternative B, the types of effects to birds resulting from temporary habitat loss would be the same as those discussed under Alternative A. As with permanent habitat loss, the degree of effects would depend on the location of gravel infrastructure and local use of adjacent habitats by bird populations. Temporary habitat loss under Alternative B could potentially have greater impact on tundra-nesting birds than under Alternative A because some areas of high bird use that are closed to development under Alternative A would be open to leasing under Alternative B.

Mortality

Bird mortality could also result from collisions with structures such as elevated pipelines, buildings, drilling rigs, towers, power lines if suspended, boats (including barges), or bridges. The potential for collisions with oil field structures or equipment is discussed under Alternative A. The magnitude of potential impacts to bird populations as a result of collisions in areas of oil and gas development will depend, among other variables, on the location and type of the structure, the species involved, the lighting regime employed and the weather conditions and would likely impact birds at the level of the individual and not at a population level. There could be an increased risk of bird collision with offshore barge and vessel traffic under Alternative B (as compared to Alternative A), due to an increase in barge traffic necessary for transportation of materials for the greater potential of facilities construction in this alternative due to the greater area open to development. Under Alternative B, ROP E-10 would require illumination to prevent migrating waterfowl from colliding with drilling structures, production facilities, and other structures exceeding 20 feet in height, although the effectiveness of the stipulation is currently unknown. Although there is no similar lighting requirement under Alternative A, the potential risk of bird collisions with oil field infrastructure could still be greater under Alternative B, because the potential benefits of illumination of facilities may not be adequate to mitigate for the presence of facilities within or near areas of high bird use and the potential for greater development in high density bird areas is higher in Alternative B.

Some predators, such as ravens, gulls, Arctic fox, and bears could be attracted to areas of human activity where anthropogenic sources of food and denning or nesting sites were present. The potential impacts of increased numbers of predators on birds are discussed under Alternative A. Increased predation pressure could have moderate impacts on tundra-nesting birds. Under Alternative B, the types of effects to bird populations would be the same as those

discussed under Alternative A. Under Alternative B, there may be the potential for greater bird mortality due to predation than under Alternative A if predators were attracted to development in areas of high bird use that are closed to leasing under Alternative A. Although both alternatives have ROPs or lease stipulations in place to eliminate attraction of predators to anthropogenic sources of food, Alternative B would require the lessee to use the best available technology to prevent facilities from providing nesting, denning, or shelter sites for ravens, raptors, or foxes. Still, it may be difficult to totally exclude ravens from nesting on oil field structures. There would be no equivalent lease stipulation under Alternative A.

Effects of Abandonment and Rehabilitation

The impacts of abandonment and rehabilitation of oil fields on birds would be similar in many respects to those incurred by construction activity. Impact types would be the same for Alternative B as described in Alternative A. Alternative B would likely have a greater impact than Alternative A as more area would be available for oil and gas development in Alternative B, potentially resulting greater total area to be abandoned and subsequently rehabilitated.

Effects of Spills

Oil spills would have similar types of effects to tundra-nesting birds under Alternative A and Alternative B. However, there would be an increased risk of a contaminant spill occurring under Alternative B. The potential for an offshore spill would increase because there would be approximately 20% more barge traffic under Alternative B than Alternative A. Offshore spills would have the potential to spread through the action of wind and currents, and could affect molting waterfowl along the coastline or in Harrison and Smith bays, as well as shorebirds feeding in littoral habitats in the planning area. The risk of an onshore spill risk increases with increased volume of oil expected to be produced. The risk (or number of) large spills under Alternative B increases by about 15% (0.3 spill – see **section 4.2.2 – Oil Spills)** and the potential spill volume from large spills increases by 1,622 barrels compared to Alternative A.

If development were to occur under Alternative B in areas of the Teshekpuk Lake Special Area that are unavailable to leasing under Alternative A, a pipeline leak or other spill on terrestrial habitats could affect greater numbers of waterfowl under Alternative B than under Alternative A because of the high concentration of nesting and molting waterfowl found in this area. Under Alternative B, Lease Stipulations K-1, K-3, K-4, and K-6 would provide setbacks from specified rivers, lakes, and the Beaufort Sea coast, within which permanent oil and gas facilities would be prohibited to help to mitigate potential effects of an oil spill on terrestrial habitats. Although Lease Stipulation K-2 was designed specifically to mitigate potential impacts to fish habitat, it could also help protect loon and waterfowl associated with lakes in the Deep Water Lakes Area.

Oil entering a river or stream could potentially spread into delta or coastal areas, where impacts to birds could be more severe. Waterfowl along the shoreline or in marine habitats and shorebirds in the littoral areas of the planning area could be impacted during the fall molting and staging period. Under Alternative B, the potential that an oil spill would enter a major river or stream would be minimized by Lease Stipulation K-1. This lease stipulation would provide setbacks of ½ to 3 miles from specified rivers, within which permanent oil and gas facilities would be prohibited, although pipelines would not necessarily be prohibited in some of these areas. Alternative A has lease stipulations with similar levels of protection.

Commercial Gas Development

The types of impacts on birds that natural gas development and production would cause would be the same as those caused by oil development described above, except that there would be no crude-oil spills and, if a gas pipeline is buried, there would be additional acreage disturbed with increased potential for impacts on bird habitat. Any effects on birds of natural gas development and production under Alternative B that are associated with previously constructed oil infrastructure, such as noise and visual disturbance from vehicles or construction activity, are expected to be temporary, nonlethal, and local, affecting a few individuals. As in the case with Alternative A, resident ptarmigan, gyrfalcons, snowy owls and ravens may be present in the area during construction activities associated with gas development; however, the impacts to these species will be slight, and migrant bird species will not be present during winter construction activities (ADNR, 2006b). Changes in vegetation community caused by burial of the pipeline could result in a loss of bird habitat. Any emergency repair of a buried pipeline that occurred in summer has the potential to disturb nesting, brood-rearing, feeding, staging or molting birds. Buried pipelines would not impact birds. Aboveground pipelines could present a collision hazard to low-flying birds.

A natural gas well blowout occurring between May and October could affect birds that are nesting, rearing young, staging, or migrating. Some mortality could result from such an incident, although it is likely that a small number of individuals would be affected. A gas pipeline leak may also cause effects on birds through the presence of response personnel and equipment. Such impacts to waterfowl would be more likely in Alternative B than in Alternative A, because Alternative B would make available for leasing and development the important bird habitat north and east of Teshekpuk Lake.

4.4.8.3 Effectiveness of Stipulations and Required Operating Procedures

The primary reason for making 213,000 acres unavailable to leasing under Alternative B is to protect important habitat for caribou and molting geese, and medium to high-density concentrations of white-fronted goose which are found on 85% of this area (Map 3-13). However, other bird species would also benefit from protection of this area. For example, medium to high-density concentrations of pintails and shorebirds are found on 86 and 84% of this area, respectively (Maps 3-15 and 3-18). Approximately half the area contains medium to high densities of tundra swans and Pacific loons (Maps 3-9 and 3-12).

Numerous lease stipulations and ROPs were developed to protect birds and their habitat within the planning area. These include the “A” ROPs, which would help lessen the impacts of solid, liquid, and hazardous wastes on birds or their habitats, and in reducing the potential for garbage to attract animals that may prey upon birds to exploration and development sites. The “B” ROPs would help limit the impact of water withdrawals on lakes, or lake habitats, used by molting geese, while the “C” ROPs govern seismic ground operations during spring and summer to prevent seismic activity-related disturbance to geese during the nesting and molting periods. ROP E-9 provides for the avoidance of human-caused increases in populations of predators of ground nesting birds. ROP E-10 requires structures to be lit in a manner which minimizes bird collisions and ROP E-11c provides means to reduce collisions between birds and above ground utility lines. Disturbances caused by aircraft are controlled within the Goose Molting Area and raptor sites under ROP “F.” Several of the “K” lease stipulations would be effective in protecting birds and their habitats, including habitats associated with rivers and lakes, the Goose Molting Area, and Coastal Area. Lease Stipulation K-4 provides for a number of measures designed to reduce the effects of development on molting geese by establishing setbacks from lake

shorelines within which construction of permanent oil and gas facilities would not be permitted, regulating water extraction from lakes, and minimizing or eliminating disturbance from aircraft during critical periods. However, this lease stipulation also allows construction of facilities, such as platforms on lakes, if these structures are located more than ¾ mile from the shoreline. Activities at offshore platforms could cause disturbance to molting geese.

4.4.8.4 Conclusion

Under all alternatives, this analysis shows that impacts birds from non-oil and gas activities would be minor. Under Alternative B, oil and gas leasing and exploration would be allowed anywhere in the planning area, with the exception of the 213,000-acre area northeast of Teshekpuk Lake. In addition, lease stipulations and ROPs would provide seasonal and spatial protection to certain environmentally sensitive areas, including Rivers Area, Deep Water Lakes, Goose Molting Area, Teshekpuk Lake Caribou Habitat Area, Pik Dunes, Colville River Special Area, Coastal Area, and Teshekpuk Lake. The exposure of birds to oil and gas activities, and therefore the level of associated impact, would be greater under Alternative B than under Alternative A, given that leasing of lands adjacent to Teshekpuk Lake could occur and that the overall scale of development would likely be greater under Alternative B.

Under Alternative B, the types of disturbances related to vehicle, aircraft, pedestrian, and vessel traffic, routine maintenance activities, heavy equipment use, facility noise, and oil spill clean-up activities would be similar to those described under Alternative A. The potential for these disturbances to impact birds would be greater under Alternative B because a greater percentage of the planning area would be available for leasing, including portions of the area of high bird use in the Teshekpuk Lake Special Area. A greater overall level of development would likely occur under Alternative B as compared to Alternative A. The potential for habitat loss and alteration to affect tundra-nesting birds would be greater under Alternative B, as compared to Alternative A, as the amount of tundra habitat that would be lost to gravel infrastructure would be greater, and there would be a higher potential for infrastructure to be located in areas of high bird use in the Teshekpuk Lake Special Area. The potential for bird mortality resulting from collisions with vehicles or infrastructure and marine vessel traffic would be greater under Alternative B because the amount of infrastructure and barge traffic would be greater. The potential for an oil spill to impact tundra-nesting birds would also be greater under Alternative B, as compared to Alternative A, given the increased amount of infrastructure and development activity. Lease stipulations and ROPs established under Alternative B would help to mitigate potential impacts to tundra-nesting birds. Effectiveness of lease stipulations are unknown at this time but are presumed to be effective.

In general, impacts to birds from non-oil and gas activities, and from oil and gas activities, would likely be additive, except in those areas where the two types of activities overlapped. Impacts to birds from exploration and development activities would also be additive. However, once exploration and development/production ceased in an area, bird populations could recover from the effects of disturbance, reducing overall effects in the planning area. In areas where two or more activities occurred, overall impacts would reflect those impacts associated with the first activity and any new impacts associated with later activities. Because of the larger disturbance area, and the potential for more oil and gas exploration and development activities, impacts to birds under this alternative would greater than those under Alternative A. Potential impacts may be greater for brant than for other species due to their apparent inability to habituate to some types of disturbance (Derksen et al. 1992), their decreasing population size, and the potential for as much as 30% of the Pacific flyway population to use the Teshekpuk

Lake molting area. Impacts could be even greater if oil and gas activities occurred in areas with high bird concentrations, with high quality habitat, or used by species of concern.

4.4.8.5 Potential New Mitigation Measures

The potential mitigation measures for Alternatives B through D are essentially the same as those presented for Alternative A in **section 4.3.8.5**. In Alternative A, they are presented as potential new stipulations, consistent with the approach for protective measures in Alternative A. In Alternative B through D, they would be considered as potential new ROPs. They are listed below in their ROP form.

1) Colville River Special Area

Potential Mitigation Measure (New ROP)
Objective: Prevent or minimize the loss of nesting habitat for cliff nesting raptors.
Requirement/Standard
a. Removal of sand and/or gravel from cliffs shall be prohibited.
b. Any extraction of sand and/or gravel from an active river or stream channel shall be prohibited unless preceded by a hydrological study that indicates no potential impact by the action to the integrity of the river bluffs.

Potential Benefits and Residual/Unavoidable Impacts

Prohibiting the removal of sand and gravel from cliffs in the Colville River Special Area will enhance existing protections to raptor nest sites in this Special Area. Preservation of cliffs would allow for the continued expansion of the breeding population of cliff nesting raptors in the Colville River Special Area by providing potential nest sites for all species of cliff nesting raptors. Prohibition of removal of sand and/or gravel from an active river or stream channel will negate to potential for subsequent erosion of downstream cliffs. Nest sites for cliff nesting raptors are potentially population limiting and destruction of cliff nest sites caused by sand/gravel mining would accelerate the existing natural erosion of cliffs in the Special Area.

Paleontological resources may indirectly benefit from this measure by providing protection to the substrates that may contain these undiscovered resources. Water quality downstream of a gravel mining operation that occurs in the river bed would benefit from the prohibition of mining in the stream bed and the subsequent erosion of downstream cliffs. Visual resources and recreation would benefit from this measure by virtue of an environment unchanged by human cause gravel mining and subsequent erosion of downstream cliffs.

Construction costs may increase in some situations if gravel needs to be transported to the construction site instead of mining of gravel near the site.

2) Raptor Protection

Potential Mitigation Measure (New ROP)
Objective: Prevent or minimize the loss of raptors due to electrocution by power lines.
Requirement/Standard
Comply with the most up to date suggested practices for raptor protection on power lines. Refer to the publication: Suggested Practices for Avian Protection on Power Lines: The State of the Art in 2006 Item #40-06-01-008 funded and produced by the Avian Power Line Interaction Committee and the California Energy Commission.

Potential Benefits and Residual/Unavoidable Impacts

Requiring all power lines and poles to be designed and constructed in a manner which reflect raptor safe configurations will prevent death of raptors by electrocution.

Additional cost may be incurred by the developer in order to provide raptor safe power lines and poles.

4.4.9 Mammals

4.4.9a Terrestrial Mammals

4.4.9.a.1 Activities Not Associated With Oil and Gas Exploration and Development

Impacts to mammals from non-oil and gas activities would be similar to those discussed under the Alternative A, but could be more frequent, greater in extent, or longer in duration. A greater number of individual animals would likely be exposed to human activities. Aircraft traffic would more often pass overhead of caribou and other terrestrial mammals during flights to or from the camps and along aerial survey routes. The disturbance reactions of caribou and other terrestrial mammals would likely be brief, lasting for a few minutes to an hour. Some terrestrial mammals might avoid inventory survey and recreation camps during the 6 to 12 weeks of activities, while bears and foxes could be attracted to the camps. Impacts from recreation and overland moves would be the same as under the Alternative A. Proposed lease stipulations and ROPs addressing land use authorizations for temporary facilities, overland moves, and recreation permits would effectively mitigate impacts from these activities on terrestrial mammals.

4.4.9.a.2 Oil and Gas Exploration and Development Activities

Under Alternative B, oil and gas leasing and exploration would be allowed throughout the planning area, with the exception of the 213,000-acre area northeast of Teshekpuk Lake. In addition, lease stipulations would provide seasonal and spatial protection to certain environmentally sensitive areas, including Rivers Area, Deep Water Lakes, Goose Molting Area, Teshekpuk Lake Caribou Habitat Area, Pik Dunes, Colville River Special Area, Coastal Area, and Teshekpuk Lake. The exposure of terrestrial mammals to oil and gas activities, and therefore the level of associated impact, would be greater under Alternative B than under the Alternative A, given that leasing of lands adjacent to Teshekpuk Lake could occur and the overall scale of development would likely be greater under Alternative B.

Effects of Disturbances

Seismic. Impacts to terrestrial mammals would be nearly the same as those discussed under Alternative A, since it is assumed that the extent of terrestrial seismic operations would be the same under all alternatives. The only change is that seismic surveys on Teshekpuk Lake are considered more likely under Alternative B than in Alternative A. It is expected that the reactions of caribou and other terrestrial mammals to disturbance would be brief, although large numbers of wintering TLH caribou would likely be encountered, depending on the location of exploration activities (see Alternative A for a description of potential adverse impacts). Some caribou and other large mammals would likely be displaced from the general area of the seismic

work. Some terrestrial mammals would avoid seismic camps, while others, such as foxes, could be attracted to the camps by food odors. The potential for disturbance to hibernating bears would remain, but bears are present at low density. Muskox and moose would most likely be present in their greatest numbers in the southern portion of the planning area.

The use of airguns for seismic work in Teshekpuk Lake during the summer would likely cause only temporary displacement of terrestrial mammals near the lake. Displacement would occur primarily from the support activity associated with the surveys, such as helicopter flights to bring equipment to the lake. Once surveys were finished and the sources of disturbance had left the area, mammals would move likely back into the area around the lake.

Exploratory Drilling. Under Alternative B, it is projected that the number of exploration and delineation wells drilled (up to 170) would be intermediate between Alternative A and Alternative C. Impacts to terrestrial mammals would be similar to those discussed under Alternative A, but somewhat greater in spatial extent, frequency, and magnitude. This would especially be so in the areas near Teshekpuk Lake where leasing would be excluded under Alternative A. Exploratory drilling would be conducted during the winter, when some mammal species are less active or less often present, although wintering TLH caribou could be present in large numbers. Exploratory drilling could also occur from pads and platforms in lakes in the TLCH Area during summer, potentially disturbing mammals found near this activity. Moose, muskox, and grizzly bears would generally experience a greater level of impacts than under Alternative A.

The implementation of lease stipulations and ROPs would minimize impacts to terrestrial mammals. These lease stipulations and ROPs would include provisions to avoid known grizzly bear dens by ½ mile, methods to avoid attracting wildlife to food and garbage, provisions to protect stream banks from damage during overland moves, provisions to minimize the effect of low-lying aircraft on wildlife (particularly over caribou winter ranges), and provisions to minimize the disturbance and hindrance of caribou in the TLCH Area.

Oil and Gas Development. Approximately 95% of the planning area would be made available for leasing under Alternative B. Leasing would be allowed throughout the planning area, with the exception of the 213,000-acre region northeast of Teshekpuk Lake.

The primary effects of oil and gas development on terrestrial mammals would be similar to those outlined under Alternative A, and would result from construction of facilities such as roads and pipelines; motor vehicle traffic within the oil field(s) and on connecting roads; foot traffic near facilities and camps; aircraft traffic; crude-oil and fuel spills contaminating tundra, stream, and coastal habitats; and habitat alteration associated with gravel mining and construction. The greatest potential for impacts to caribou would be through disruption of calving areas and interference in the movement of mosquito-harassed TLH caribou between insect-relief habitat and foraging areas. These impacts would likely be greater under Alternative B than under Alternative A, given the larger development scenario that would affect approximately 446 additional acres of habitat under long-term disturbance. Functional loss of habitat would be greater than the number of acres indicated as the actual development footprint. Wolfe (2000) suggested that when caribou in the CAH avoided areas within 2.5 miles of roads and pipelines, the functional habitat loss increased from 2% (the immediate footprint of roads and gravel pads) to 29%.

Construction of permanent roads within the planning area would increase access to the area and could increase public and subsistence hunting of terrestrial mammals if those roads were

ever connected to villages or other road systems. Among ungulate species, caribou would be most impacted by increased access for hunting, but other species (moose in particular) may also be impacted depending on the location of permanent roads. The overall number of animals taken would be unlikely to increase dramatically since most hunting would be for subsistence, but roads could focus hunts in particular portions of the planning area. Hunting pressure and harvests have increased for many wildlife species near the TAPS since its construction, but have not produced adverse population effects (TAPSO 2001). It is unlikely that the more remote roads associated with oil and gas development in the planning area would have as great an effect on wildlife populations as occurred along the TAPS corridor.

Caribou

Although much of the construction associated with oil and gas development would occur primarily during winter, development would bring year-round facilities and activities to caribou range. If a field were developed in the area surrounding Teshekpuk Lake (excluding the portion unavailable to leasing), production pads, pipelines, within-field roads, and other facilities would be located within areas used by the TLH caribou for calving, insect relief, and wintering. A field development in the northern section of the planning area would also require a connector pipeline to link the oil field with facilities to the east.

The types of impacts of field development on caribou would be similar to those outlined under Alternative A. However, given the greater possibility that a field would be developed within the calving, insect-relief, and wintering grounds of the TLH caribou, impacts to caribou could be greater under Alternative B than under Alternative A. Overall, the level of impact would be dependent on the specific location of any oil field—a field in the central or southern portion of the planning area would not impact the TLH caribou calving grounds, although such a development could still affect migratory movements of TLH and WAH caribou as well as activities on their wintering ground.

Development in the TLH caribou calving grounds could displace some calving animals within 2½ miles of roads. Movements of some cows and calves across roads would also likely be reduced, and cow caribou might avoid crossing the roads during the calving season. Some TLH caribou movements during the insect-relief season (late June to mid-August) would likely be affected by pipelines and road traffic. The most critical corridors for movement to the coastal insect-relief area are through the narrow areas between Teshekpuk Lake and the Kogru River to the east and between the lake and Smith Bay to the northwest. These areas would be open to leasing under Alternative B. Caribou must pass through them to get to and from insect-relief areas. The area to the east of Teshekpuk Lake is a particular problem because nearly all of the parturient cows pass through this area either shortly before or after calving (Person et al., in press). Any development that occurs on the limited amount of habitat that is used by caribou migrating through this corridor would likely affect caribou movements. Development in the corridors could result from oil finds in the area of the corridors or from a pipeline that would come from petroleum fields north of the lake. Under Alternative B, the region northeast of Teshekpuk Lake would be excluded from leasing. However, pipelines could be allowed in the excluded area as a result of technological limitations, economics, logistics, or other factors. The result would be an increased potential for oil and gas development activities to affect caribou use of this corridor. Additionally, the area that would be excluded from leasing does not extend to the coast, except near Cape Halkett, suggesting that there could be some development along the coastline. While a set-back from the coast is stipulated (Lease Stipulation K-6), development in the coastal area would likely impact caribou use of insect-relief areas near the coast.

Studies done over the last decade have indicated that TLH caribou show high fidelity to the calving area near Teshekpuk Lake and that caribou that calve in the traditional calving area have much higher calving success than caribou found outside the area. Collared caribou that are found within the currently protected areas (as identified in 1998 ROD) during calving season have much higher calving success than caribou found outside the areas. In surveys conducted from 1994-2003, 155 of 171 (91%) TLH caribou that calved successfully calved within these protected areas. Of the 195 caribou cows that were found within the protected areas, 79% calved successfully. Of the 65 cows that were found outside the protected areas during calving season, 25% calved successfully (Carroll et al. 2005).

If the TLH is partially displaced from its calving area, as the CAH has been, or if caribou are impeded from reaching the calving area, recent surveys indicate that calving success would most likely be reduced. While there have been no experiments conducted with the TLH to determine whether oil development in the calving area would displace caribou or affect the productivity of the herd, caribou behavior during 1997 and 2001 suggest oil development in the TCH calving area could impact caribou. During 1996-97, most of the herd migrated much farther south than usual and many cows arrived late to the calving area. Only 8 of 21 collared caribou were found in the calving area during calving time and 6 of these calved successfully. Of the other 13 collared cows, only one calved successfully for an overall successful calving percentage of 33%. In 2001, heavy snow and a late snow melt-off slowed the migration and only 16 (44%) of 36 collared cows calved successfully. Calving success for collared cows that did make it back to the calving area in 2001 was much better (88%) than cows that did not make it back (10%). This suggests that if oil development takes place in such a way that it displaces caribou from the calving area or interferes with their ability to get to the calving area, it could have an effect on productivity and population numbers (Carroll 2003; Carroll et al. 2005). Although controversy exists over whether populations level effects for the CAH following displacement from portions of its calving range have been demonstrated (Cronin et al. 1998; Cameron et al. 2005), the most recent study of CAH productivity in the oil fields suggests that habitat quality in the calving area in one year may affect calf size at birth in the following year (Arthur and Del Vecchio 2006). Calf size at birth in turn influences calf size at the end of the first summer, which has consequences for survival through the following winter.

The types of impacts of field development on caribou would be similar to those outlined under Alternative A. However, given the possibility that a field would be developed within the calving, insect-relief, and wintering grounds of the TLH, impacts to caribou could be greater under Alternative B than under Alternative A, with the exception that Alternative B would require a minimum pipeline height of 7' as opposed to only 5' for Alternative A. The WAH caribou could be exposed to oil development facilities in localized areas. Moose, muskoxen, grizzly bears, wolves, wolverines, foxes, and small mammals could be locally affected by activities associated with oil and gas exploration and development. Impacts to mammals would be similar to those discussed under Alternative A, but could be more frequent, greater in extent, or longer in duration. A greater number of individual animals would likely be exposed to human activities. Aircraft traffic would more often pass over caribou and other terrestrial mammals during flights, and a greater amount of habitat would potentially be permanently lost.

Traffic associated with hauling gravel from outside of the planning area could result in local disturbance and displacement of caribou within one to a few miles of the operations. A pipeline linking oil fields in the planning area with facilities at the Alpine and Kuparuk oil fields would result in the disturbance and displacement of some caribou during winter construction, due to air traffic and to vehicle traffic along ice roads. It is expected that these disturbances would be

short term (but see Alternative A's discussion of potential effects of seismic operations) and occur within about one to a few miles of the pipeline corridor.

Moose

Moose occur in low densities in the planning area during the summer and are concentrated in major drainages at the southern edge of the planning area in the winter (Map 3-26). Unless an oil field were to be developed in the southern portion of the planning area, development would be unlikely to impact moose. Under Alternative B, impacts to moose would be similar to those discussed under Alternative A, because the probability of a development in the southern portion of the planning area would be the same or similar.

If gravel were mined from the southern portion of the planning area, a temporary displacement and disturbance of moose could occur. Borrow pit operations could potentially destroy or degrade about 50 acres of moose habitat for each gravel pit if gravel borrow operations occur in the southern portion of the planning area.

Muskox

Muskoxen occur in low densities in the planning area, and they may not be present year-round in all years. Potential effects of oil and gas development activities include displacement and disturbance of individual animals, direct habitat loss from gravel mining in river floodplains and at oil field facilities, and indirect habitat loss through reduced access caused by physical or behavioral barriers created by roads, pipelines, and other facilities. Under Alternative B, impacts would be similar to those under Alternative A, although they could be greater in duration and area, given the larger overall development scenario. Impacts may be greater if development were to occur in the southern portion of the planning area.

Grizzly Bears

Major sources of noise include construction of roads, installation of crude oil pipelines, pump stations, gravel mining, and drilling operations. These activities could disturb grizzly bears within a few miles of the noise sources. Industrial activities and human presence could also cause potentially serious disturbances to denning bears. Under Alternative B, impacts to grizzly bears would be similar to those that would occur under Alternative A, although the extent and duration of impacts could be greater because of the larger overall development scenario, depending on the location of the field development. Grizzly bears are present at low densities in the northern portion of the planning area, but could be attracted to some activities. It is likely that the greatest number of bears would be encountered during development activities in the southern portion of the planning area, since the greatest amount of suitable habitat is located in this area.

Wolves

Under Alternative B, oil and gas development would have a minimal impact on wolves, similar to Alternative A. Potential effects to wolves would include short-term disturbance from air and surface traffic and human presence, and increased hunting and trapping pressure through improved access or increased human presence associated with oil development. If caribou abundance were negatively affected by oil and gas development, wolf abundance could in turn be affected. However, wolves are not abundant in the planning area.

Wolverines

The potential effects of oil and gas development on wolverines under Alternative B are the same as under other alternatives and could include disturbance from air and surface vehicle traffic, increased human presence, and habitat alteration. Because wolverines are considered a shy

and secretive species, they could be sensitive to oil exploration and development activities and abandon habitat areas near oil development. If caribou abundance was affected by oil development, wolverines could be affected in turn. Alteration of riparian habitats through gravel excavation or pipeline construction could affect wolverines, especially during the winter, when these habitats provide cover and important hunting areas. Wolverines are present at low density in the planning area and sightings have been infrequent. Documented sightings and harvest locations suggest that wolverines could be encountered along rivers and in the vicinity of Teshekpuk Lake. Under Alternative B, some wolverines could be displaced in the vicinity of oil field facilities. Impacts under this alternative are likely to be similar to or slightly greater than those that would occur under Alternative A, given the larger overall development scenario.

Foxes
Under Alternative B, impacts to Arctic and red foxes would be similar to those discussed under Alternative A, although they could be greater in duration and extent. Oil and gas development activities could affect foxes by increasing the availability of food and shelter. An increase in the fox population associated with oil development could affect some prey of foxes (such as ground-nesting birds and molting waterfowl) in the development area and over a region larger than the oil field itself (Burgess et al. 1993).

Other Mammals
Small rodents and their predators would be affected locally (i.e., through direct mortality of individuals or small groups of lemmings and voles, or through loss of habitat) along pipelines, gravel pads, and other facilities. Arctic ground squirrels sometimes den in gravel fill in the oil fields (Shideler and Hechtel 2000). The availability of suitable burrowing habitat could increase local densities of ground squirrels. Under Alternative B, impacts to small mammals would be similar to or slightly greater than those that would occur under the Alternative A, given the larger overall scale of the development scenario.

Effects of Abandonment and Rehabilitation

Abandonment and rehabilitation activities are expected to disturb and displace terrestrial mammals in a manner similar to that associated with construction. The intensity of the disturbance might be less than during construction, however, because it is possible that caribou, muskoxen, and other terrestrial mammals would have become habituated to road and air traffic over the course of construction and operation of the facilities. Some individuals could be killed by collisions with road traffic. If roads were left in place and maintained in useable condition upon abandonment, they could continue to provide improved access to hunting areas, with consequent hunting pressure on caribou and other subsistence species. Revegetation of the roads, pads, and the airstrip left in place would facilitate rehabilitation of habitat, but plant communities on these raised gravel structures would likely be different from those that prevail in adjacent areas and may include invasive species. Pads, roads, and airstrips could provide some insect-relief habitat for caribou, if left in place (Murphy and Lawhead 2000). If gravel fill was removed and the pad revegetated with vegetation similar to the surrounding plant communities, caribou, and possibly other terrestrial mammals, would use the area. Foam insulating materials that could be used in pad construction could be broken up in the course of removal. If some of this foam escapes being cleaned up, it may be used by foxes as denning material. Depending on the material's toxicity and the amount ingested by a fox, this could cause mortality, though the numbers of foxes killed would likely be very small. Overall, a greater amount of development is assumed under Alternative B than under Alternative A, providing a potential of greater impacts from abandonment and rehabilitation. However, they

would likely be expressed over a longer time period resulting in no population level effects from these activities in either case.

Effects of Spills

Typical refined products that are spilled on the Alaska North Slope include aviation fuel, diesel fuel, engine oil, fuel oil, gasoline, grease, hydraulic oil, transformer oil, and transmission oil. The extent of environmental impacts would depend upon the type and amount of material spilled, the location of the spill, and the effectiveness of the response. The majority of small spills would be contained on the gravel pad and would have no impact on terrestrial mammals or their habitat.

The impacts of oil spills on terrestrial mammals are described under Alternative A (**section 4.3.9, *Mammals***). Compared to Alternative A, the risk of oil spills would be greater, but still small, under Alternative B, given the slightly greater estimate of spills. Activities occurring in the vicinity of Teshekpuk Lake could increase the likelihood that a spill would reach the lake under Alternative B. Because most spills would be small and affect a small area, the majority of impacts to terrestrial mammals would result from disturbance associated with spill clean-up activities rather than direct oiling.

Commercial Gas Development

The types of impacts from gas development under Alternative B would be similar to, but potentially greater in magnitude, than those described for Alternative A, because under Alternative B more important caribou calving and insect relief area is made available for leasing. Buried pipelines would have no impact on caribou movement, though disturbance could occur during winter construction in approximately the same way as it would occur by construction of aboveground pipeline described above and, like in Alternative A, about 290 acres of habitat would be altered by change in vegetation along the buried pipeline route. The noise associated with a 10- to 20-acre compressor station may cause avoidance, but the pad's raised surface may attract caribou seeking insect relief.

If a gas pipeline was elevated on a set of VSMs separate from oil-pipeline bearing VSMs, caribou movement could be hindered.

Construction and operation of gas facilities would likely impact other terrestrial mammals in a manner similar to and in like proportion to the impacts associated with oil development and in a way similar to that described for gas development impacts under Alternative A.

In the event of a natural gas well blowout or pipeline rupture, there would be a short-term release of gas (1 day) that could extend downwind for about 1 km and would quickly dissipate once the blowout or leak was stopped. Terrestrial mammals in the immediate vicinity of the blowout could be killed. Natural gas and condensates that did not burn in the blowout would be hazardous to any terrestrial mammal exposed to high concentrations. Given the small area that would be exposed to the plume and the rapid dissipation of the gas, it is not likely that any animals other than individuals present in the immediate vicinity at the time of the blowout would be affected. The likelihood of caribou, moose, muskoxen, wolves, or grizzly bears being exposed to toxic amounts of gas and condensates is very low and (should it occur) would probably only affect a few individuals. Smaller, less mobile species with small home ranges, such as squirrels, voles, and lemmings may be affected in larger numbers. However, there would be no population level impacts on any species.

4.4.9.a.3 Effectiveness of Stipulations and Required Operating Procedures

Numerous lease stipulations and ROPs were developed to protect mammals. These include the "A" ROPs, which have been developed to reduce the potential for direct mortality due to oiling, ingestion of toxic materials, or contamination of habitat, prey species, and forage species, and to reduce the attractiveness of industrial sites to predators that could result in elevated predator populations. Increased numbers of predators such as foxes may put personnel at risk, which could result in predator removal.

Lease Stipulation D-1 would prohibit exploratory drilling in lakes, streams, lakebeds, and active floodplains unless impacts to wildlife were minimal, while Lease Stipulation D-2 would be effective in minimizing surface impacts from exploratory drilling by limiting exploratory drilling to temporary facilities such as ice pads, ice roads, ice airstrips, and temporary platforms, unless the lessee were to demonstrate that construction of permanent facilities was environmentally preferable.

Required Operating Procedure E-1 would be effective in protecting wildlife resources by requiring that all roads be designed, constructed, maintained, and operated to create minimal environmental impacts, while ROP E-7 would require that pipelines and roads be designed to facilitate caribou passage by elevating all aboveground pipelines at least 7 feet above the ground providing better passage during winter when snow is on the ground, burying pipelines, or providing ramps to facilitate caribou movements. In addition, ROP E-7(c) would require that a minimum distance of 500 feet separate pipelines and roads, when feasible. If fully implemented, these ROPs would be effective in reducing (but not eliminating) the impacts of oil development on caribou movements (Lawhead et al. 2006). Since caribou are sensitive to humans on foot and moving vehicles, there would be some negative effects on their ability to freely move through the area, regardless of how well the field was designed.

Required Operating Procedure F-1 would minimize the effects of low-flying aircraft on terrestrial mammals by requiring an altitude of at least 1,000 feet AGL (except for takeoffs and landings) over caribou winter ranges, limiting the number of takeoffs and landings in support of operations, and requiring aircraft altitudes of at least 2,000 feet AGL (except for takeoffs and landings) over the TLCH Area from May 20 through August 20. Assuming that aircraft operators were aware of the potential effects of aircraft on wildlife and took the appropriate actions to minimize those effects, disturbance impacts to terrestrial mammals could be effectively reduced.

Lease Stipulations K-5 and K-6 would require that the operator minimize disturbance and hindrance of caribou, or alteration of caribou movements through portions of the TLCH Area and the Coastal Area that are essential for all season use, including calving and rearing, insect relief, and migration. These lease stipulations would require studies of caribou movement, would restrict exploratory drilling, would protect major land corridors, would require field design that takes caribou movements into account, and would require various ground and air traffic controls.

4.4.9.a.4 Conclusion

Under Alternative B, oil and gas leasing and exploration would be allowed anywhere in the planning area, with the exception of the 213,000-acre area northeast of Teshekpuk Lake. In addition, lease stipulations and ROPs would provide seasonal and spatial protection to certain

environmentally sensitive areas, including Rivers Area, Deep Water Lakes, Goose Molting Area, Teshekpuk Lake Caribou Habitat Area, Pik Dunes, Colville River Special Area, Coastal Area, and Teshekpuk Lake. The exposure of terrestrial mammals to oil and gas activities, and therefore the level of associated impact, would be greater under Alternative B than under Alternative A, given that leasing of lands adjacent to Teshekpuk Lake could occur and that the overall scale of development would likely be greater under Alternative B.

Among the terrestrial mammal populations that could be affected by management actions under Alternative B are the TLH, WAH, and CAH caribou. Caribou could be exposed to helicopter traffic and other human activities associated with resource inventories, seismic operations, exploratory drilling, and pipeline construction. The TLH caribou movements within calving, insect-relief, and wintering areas could be disrupted by oil development activities. Although much of the construction associated with oil and gas development would occur primarily during winter, development would bring year-round facilities and activities into caribou range. If a field were developed in the area surrounding Teshekpuk Lake (excluding the portion unavailable to leasing), production pads, pipelines, within-field roads, and other facilities would be located within areas used by the TLH for calving, insect relief, migration, and wintering. A field development in the northern section of the planning area would also require a connector pipeline to link the oil field with facilities to the east.

It is expected that impacts to terrestrial mammals in the vicinity of Teshekpuk Lake would be greater under Alternative B than under Alternative A, particularly with respect to caribou calving and insect-relief habitat. Overall, impacts throughout the planning area would be greater under Alternative B, given the greater overall scale of the planned development. In general, impacts to mammals from non-oil and gas activities, and from oil and gas activities, would likely be additive, except possibly in those areas where both types of activities occurred. Impacts to mammals from exploration and development activities would also be additive, except possibly for habitat impacts where development occurred in habitats previously disturbed during exploration. In areas where two or more activities occurred, overall impacts would reflect those impacts associated with the first activity and any new impacts associated with later activities.

The approximately 213,000 acres that would be unavailable to leasing are important to caribou migrating between calving and insect-relief areas and the wintering grounds. In addition, lease stipulations and ROPs have been developed to further protect caribou found near Teshekpuk Lake and using coastal environs. Based on the amount of habitat with a potential to be affected, the potential for impacts to mammals under this alternative would be about 10% more than Alternative A. If oil and gas activities occurred in areas with an abundance of caribou or other mammals, or in areas with high quality habitat, impacts could be greater than those based strictly on number of acres of habitat impacted.

4.4.9-b Marine Mammals

4.4.9-b.1 Activities Not Associated With Oil and Gas Exploration and Development

The principal non-oil and gas activities occurring in the planning area would be aircraft traffic (both rotary- and fixed-wing) associated with surveys and wildlife studies; ground activities such as resource inventories, paleontological excavations and research, and recreational camps; overland traffic; and human foot traffic. Overland moves would occur during the winter on stable sea ice or frozen tundra, and could impact small numbers of seals. Most of the other non-

oil and gas activities would take place in summer and early fall (June-September) and could only impact marine mammals if they occurred along the coast of the planning area. These types of activities would be either highly localized (worksite/camp) or transient (surveys and inventories) could cause short-term (hours for a single event, or several days to 2-3 weeks if a camp or worksite is located immediately next to the coast in areas used by marine mammals) displacement or limited harassment of hauled-out seals.

Overland moves would take place during the winter, and follow routes from Prudhoe Bay or Oliktok Point to Barrow or Nuiqsut. Overland routes would occur over stable sea-ice and over frozen tundra. Vehicle and sled trains could disturb denning ringed seals if the routes occurred over denning habitat in floating fast-ice, and could temporarily displace basking seals near the traffic route. Most over-ice routes are expected to be over land-fast ice and across shallow water (<10 feet). Ringed seals occur in very low densities in these shallower areas (~0.03 seals/mi^2) and do not appear to be significantly affected by construction and operation on sea ice roads (Moulton et al. 2005).

Small fuel spills would likely occur in association with resource inventories and surveys, recreational activities, and overland moves. These spills would most likely involve aviation fuel and other light-fraction hydrocarbons fuels that would evaporate and disperse rapidly, and would be cleaned up immediately whenever possible. These small spills would not be expected to impact marine mammals in or near the planning area.

The effects of non-oil and gas activities on marine mammals in the planning area should be localized and short term.

4.4.9-b.2 Oil and Gas Exploration and Development Activities

The potential types of impacts under Alternative B are the same as Alternative A. The frequency, spatial extent, and magnitude (intensity and duration) of the impacts likely will vary between alternatives in relation to the total amount of area open to development, the location of the areas open, and the Lease Stipulation and Required Operating Procedures. Alternative B makes areas north of Teshekpuk Lake open to exploration and development that are closed under Alternative A. It also results in a development scenario that estimates approximately 12% (446 acres) more permanent disturbance than Alternative A. However, as noted, it is the change in areas open to development that is likely to have the most influence on the likelihood and severity of impacts to marine mammals.

Effects of Disturbances

Seismic

Seismic exploration is expected to have the same potential for affect and likelihood to occur as under Alternative A. However, the ¾ mile coastal buffer required by ROP K-4 would reduce the attractiveness of the Atigaru/Kogru area making the likelihood of seismic in these areas lower than under Alternative A. The low likelihood of seismic under this alternative combined with the expected very low density of seals in these shallow areas (Moulton et al. 2005) makes it unlikely that seals would be affected by seismic work.

Visual and Noise Disturbance

Aircraft. The effects of aircraft disturbance would be similar to those described under the Alternative A, but could be greater in extent, given the greater number of pads and production facilities expected under Alternative B. More importantly, because development would be allowed north of Teshekpuk Lake the number of aircraft that would regularly occur over areas that may be used by marine mammals would increase. Aircraft would generally fly at 1,000 feet AGL, minimizing the potential for disturbance to seals and most likely whales (Born et al. 1999, Patenaude et al. 2002, Richardson and Williams 2004, Moulton et al. 2005).

Shipping. Under the development scenario for Alternative B, the projected levels of development and related activities could be affect 12% more area than under the Alternative A. The greater level of estimated development could result in a greater potential for disturbance to marine mammals from increased barge traffic used to transport supplies and modules for development. It is expected that the difference in impacts from shipping among alternatives is proportional to the difference in number of vessel trips. Six to 12 sealifts 1-2 every 10 years, would be required to support development of the estimated CPFs, totaling 180 to 360 barges over an approximately 60 year period (approximately 20% more than estimated for Alternative A). In addition, it is possible that barges could be landed on the northern coast of the planning area, most likely at Lonely. In this scenario, increased barge traffic during the summer could result in more disturbance and displacement of whales and seals than under Alternative A because barges would be maneuvering off the coast and be in place for several days instead of transiting past. Although like Alternative A and B the displacement/disturbance is expected to be localized in time (only occur within a short distance <1 mile for seals, 1-4 miles for whales) in time and short-term (hours or days). It is not expected that effects would levels that could result in substantial impacts to individual marine mammals or populations, although the fitness of some individuals could be impacted.

Contaminant Spill

The effects of a spill on marine mammals would be as described under the Alternative A. The likelihood of a spill reaching or occurring in areas used by marine mammals is higher due to the greater amount of development but is still very low. Although a greater area is open, Lease Stipulation K-4 places a ¾ mile buffer along the entire coastline, including the area around Atigaru Point, which is open under Alternative A.

Collisions

The likelihood of a vessel strike is influenced by the number of vessels traveling through an area over time. Speed probably has an influence on the likelihood of a collision and does increase the potential that a collision will result in sever injury or death (Laist et al. 2001). Alternative B would result in an estimated 20% more vessel traffic with a commiserate increase in the likelihood of a collision. Given the expected low rates of collisions (George et al. 1994), this change while moderate in percentage terms is likely a minor risk in actual number of animals injured or killed.

Effects of Abandonment and Rehabilitation

Impacts of abandonment and rehabilitation activities are expected to be similar to those for construction. Given the expense of transport vessel traffic is expected to be substantially lower than occurred during construction as large modules or other equipment may be moved to other

development or stored at regional staging areas rather than moving it off the North Slope. The potential for impacts is expected to be proportionally higher compared to Alternative A.

4.4.9-b.3 Effectiveness of Stipulations and Required Operating Procedures

Under Alternative B, performance-based lease stipulations and ROPs designed to mitigate impacts of oil and gas development on other resources would be implemented.

Required Operating Procedures that address waste prevention, handling, disposal, and spills should be effective in minimizing impacts to marine mammals from development in the planning area. These include ROP A-7(b), which would prohibit the discharge of produced fluids into the marine environment, where currents and water depths, in combination with other conditions, would be inadequate to prevent impacts to known biologically sensitive areas.

Required Operating Procedure C-1 (b) would prohibit the cross-country use of heavy equipment and seismic activities within 1 mile of known or observed seal birthing lairs. This ROP would also require operators to consult with the USFWS or NOAA Fisheries Service before initiating activities in coastal habitat between October 30 and April 15.

Lease Stipulation K-1(a) would require a 1-mile setback from the Colville River within the planning area.

Lease Stipulation K-1(e) would prohibit permanent oil and gas surface facilities within 3 miles of Fish Creek. A 3-mile setback would be highly effective in minimizing the potential for oil and gas leasing and development activities to negatively impact beluga whales in Fish Creek.

Lease Stipulation K-6 would prohibit the placement of permanent facilities within ¾ mile of the coast, except where technological limitations, economics, logistics, or other factors necessitated a structure. Under these circumstances, the use of a previously occupied site (Camp Lonely, Husky/USGS drill sites, and DEW-Line sites) would be considered. Prohibiting new permanent facilities within ¾ mile of the coast should be effective in reducing the potential for disturbance to seals (spotted, ringed, and bearded) hauled out on beaches in summer, or hauled out on the ice during winter and spring. Lease Stipulation K-6 would also reduce the potential for disturbance to cetaceans that occur in nearshore habitats (gray whales and beluga whales) along the coast of the planning area.

4.4.9-b.4 Conclusion

Under Alternative B, the effects of non-oil and gas activities on marine mammals, would be short term and/or localized, occurring within one mile of aircraft corridors, survey activities, recreational camps, and overland moves.

Oil and gas leasing and development activities under Alternative B would likely cause a greater level of noise and disturbance, primarily near the Colville River Delta and inner Harrison Bay area than under the Alternative A. Effects should be localized (within 1 mile of aircraft corridors and activities) and short term (generally less than 1 year). Lease Stipulation K-6 would minimize the potential for development to impact ringed seals, spotted seals, and beluga whales, in a small area in Harrison Bay south of Atigaru Point, where activities could occur under the Alternative A. While exploration could occur in this area under Alternative B, the effects of seismic exploration would be limited to short-term, localized disturbance to denning or hauled out ringed seals.

A small number of ringed seals, spotted seals, and beluga whales could be affected by oil spills entering the Kogru River, Colville River, or drainages that empty into the Colville River, Fish Creek, or Judy Creek. The likelihood of such and event is small and not expected to occur. It is expected that any losses would be small.

The effects of development under Alternative B are expected to be somewhat greater than those under the Alternative A due to the greater amount of exploration and development projected to occur under this alternative. However, these effects would be short term, with few impacts on marine mammal populations. Since nearly all exploration and development activity would occur onshore under all alternatives, the potential for impacts to marine mammal resources under Alternative B would be slightly greater than those that could occur under the Alternative A.

4.4.10 Threatened and Endangered Species

This section discusses the potential effects to bowhead whale, spectacled and Steller's eiders, and polar bear which could result from management action in the planning area under Alternative B. Whales would be most affected by disturbance and oil spills. Most, but not all, activities that could potentially affect eiders and polar bears in the Planning Area would be associated with oil and gas exploration and development. Other activities that could occur in the planning area include subsistence hunting, recreational use, and activities associated with scientific survey and research camps.

4.4.10-a Bowhead Whale

4.4.10-a.1 Activities Not Associated With Oil and Gas Exploration and Development

Under Alternative B, effects to bowhead whale from non-oil and gas activities would be similar to those that would occur under Alternative A. Impacts from non-oil and gas activities would have no or minor impacts on individual bowhead whales or bowhead whale populations.

4.4.10-a.2 Oil and Gas Exploration and Development Activities

Effects of Disturbances

The effects of oil and gas activities on bowhead whale would be similar in type but of somewhat greater magnitude under Alternative B than under Alternative A, given the greater area that is available for development. There would be an approximately 20% increase in barge traffic and a greater likelihood that barges would come ashore and be unloaded along the coast of the planning area. Because some areas north of Teshekpuk Lake would be open to oil and gas leasing and development, there is also a greater likelihood that regular aircraft operation over marine waters would occur. As discussed under Alternative A the effects of those activities are expected to be limited to short term avoidance behavior, but more studies are required to assess the consequences of eliciting this behavior. It is unknown if the he potential increase in these disturbance activities would result in an impact level that significantly reduces the fitness of individual bowhead whales, although it is unlikely that population level effects would be detected.

Contaminants

There would be a greater potential for oil spills under Alternative B than under Alternative A, given the larger area available for development and higher levels of development activity that would occur under Alternative B. However, it would still be unlikely that spilled oil would reach bowhead whale habitat, unless development occurred along the coast. The potential for an accidental release of contaminants from barge traffic would increase slightly due to the estimated increase in number of barges, but this remains an unlikely event (although the probability of a spill occurring would increase as a result of 20% more barge traffic).

The southward edge of the migration corridor could be deflected northward due to any vessel activity associated with containment and clean-up activities occurring during the fall migration. However, impacts to individual bowhead whales or the whale population would be minor, except in the case of a very large spill coincident with the fall migration, which is very unlikely.

Collisions

Alternative B is estimated to result in an approximate 20% increase in barge traffic over Alternative A. Development of all estimated facilities is not expected to occur concurrently but sequentially. The projected increase in barge traffic would not all occur in one year but would consist of 20% more sealifts than Alternative A spread over some period of time, likely separated by 5 to 10 years. The likelihood of a vessel strike is influenced by the number of vessels traveling through an area over time thus the likelihood of a collision is increased under Alternative B compared to Alternative A. However, given the expected low rates of collisions observed in the past (George et al. 1994), those expected based on the low rate of speed barges typically travel (Laist et al. 2001), and that barges usually are active only during the earlier portion of migration, this change, while moderate in percentage terms is likely a minor risk in actual number of whales injured or killed.

Effects of Abandonment and Rehabilitation

Impacts of abandonment and rehabilitation activities are expected to be similar to those for construction and moderately higher than under Alternative A. Effects could occur from aircraft, barges used to remove materials from the planning area and potential spills.

Commercial Gas Development

If natural gas development and production occur in the planning area, it is unlikely that bowhead whales would be affected other than temporary, nonlethal effects from marine vessels as described for traffic associated with oil development.

4.4.10-a.3 Effectiveness of Stipulations and Required Operating Procedures

There are no Stipulations or Required Operating Procedures specific to bowhead whales, but several would indirectly reduce the potential that any oil spill would reach marine waters. Lease stipulation K-1 requires no development setbacks from the banks of major rivers in the planning area. While this stipulation does not prohibit pipelines from crossing rivers, development would be prohibited from within ½ to 3 miles from the banks. This should substantially reduce the potential for a large spill originating from pads or pipelines parallel to the river channel to reach the river and be transported from to marine waters. Lease

Stipulation K-4 requires a ¾ mile set back from the coast which would have a similar effect as K-1, reducing the potential for a large spill to reach marine waters.

4.4.10-a.4 Conclusion

Alternative B is expected to result in approximate 12% more surface disturbance potentially distributed over a greater area of the planning area than Alternative A, with a commiserate increase in barge traffic, aircraft, and spill potential. Therefore there is a greater likelihood of impacts to bowhead whales, including behavioral displacement from high-density foraging areas, injury, and mortality from ships collisions and oils spills. However, a relatively small proportion of the population is projected to be affected by these impacts. In those years where bowheads occur in shallower waters during fall migration, the number affected could be higher, but potential effects are not expected to be severe enough to lead to changes in the population unless a very large oil spill occurred in the marine environment.

4.4.10-b Spectacled and Steller's Eiders

4.4.10-b.1 Activities Not Associated with Oil and Gas Development and Exploration

Non-oil and gas activities that could affect spectacled and Steller's eiders under Alternative B would be the same as those listed under Alternative A—private or commercial air traffic, aerial surveys to inventory wildlife or other resources, summer research camps, hazardous material or debris removal, subsistence hunting and fishing, and recreational camps and boating activity. Under Alternative B, a larger area is available for permanent oil and gas development than under Alternative A. However, the potential for non-oil and gas activities to disturb, displace, or cause mortality to eiders would likely be similar under the two alternatives. ROPs would effectively mitigate some of the potential effects of non-oil and gas activities on these threatened eider species.

4.4.10-b.2 Oil and Gas Exploration and Development Activities

Seismic

The effects of seismic exploration on eiders is expected to be the same as under Alternative A as similar levels of seismic exploration are predicted for all alternatives (**section 4.2.1.2**). Although under Alternative B seismic could be conducted on Teshekpuk Lake this would be done over-ice – if at all.

Exploration

Under Alternative B, the potential effects of ice-road and ice-pad construction would be similar to those described under Alternative A, and would involve the temporary alteration of tundra vegetation. Since a larger area would be available to oil and gas exploration activities under Alternative B than under Alternative A, the associated impacts to eiders would also potentially be greater under Alternative B.

Predators, such as glaucous gulls and Arctic foxes, could be attracted to anthropogenic food sources associated with summer maintenance of exploratory drilling and seismic equipment or winter exploratory activities. Under Alternative B, the potential for increased predation of eiders by predators attracted to development compared to Alternative A would be reduced by

ROP A-2, although the relatively greater amount of exploration drilling would increase the likelihood of predator attraction under Alternative B. The typical short time period and seasonality of exploration would reduce the likelihood that predators would discover any human-provided food source as well as reducing the likelihood of predators persisting in the area because there would be no recurring anthropogenic food source. Furthermore, since exploration is primarily a winter activity, avian nest predators would not be present, except for possibly common ravens).

Development and Production

Activities related to oil development and production in the planning area, such as vehicle, aircraft, pedestrian, and boat traffic, routine maintenance activities, use of heavy equipment, oil-spill clean-up activities, and aerial surveys to inventory wildlife or other resources, could cause disturbances that would affect eiders. Under Alternative B, the types of disturbances to eiders would be the same as those discussed under Alternative A. These disturbances could result in temporary displacement from preferred foraging, nesting, or brood-rearing habitats, decreased nest attendance or nest abandonment, and increased energy expenditures that could affect physiological condition and rate of survival or reproduction. The likelihood for impacts to eiders would depend on the location of the disturbance, the number of eiders in the area, and the time of year. Under Alternative B, these impacts would likely be greater than those compared to Alternative A because of the greater area that is available for development under Alternative B compared to Alternative A.

The potential for disturbance to threatened eiders from activities on roads and pads would likely be greater under Alternative B, as compared to Alternative A, because areas that support relatively high spectacled eider concentrations occur in portions of the Goose Molting Area that would be available for oil and gas leasing under Alternative B, but not under Alternative A, although the areas of highest eider densities would remain under the RSO area.

Under Alternative B, as compared to Alternative A, there would be a greater potential for disturbance to eiders to occur within the 5 to 6 mile wide band south and west of Teshekpuk Lake that would be open to surface activity under Alternative B, but closed under Alternative A. Lease Stipulation K-5, designed to protect the Teshekpuk Lake Caribou Habitat Area, would also help reduce disturbance effects to eiders by placing limits on various types of activities on roads and pads between May 20 and August 20.

Under Alternative B, there could also be a greater level of disturbance to eiders in the Deep Water Lakes Area south of Teshekpuk Lake, than under Alternative A. Under Alternative A, no permanent oil and gas facilities would be permitted within ¼ mile of the any fish-bearing lake. Under Alternative B, facilities would generally not be permitted within this buffer, but could be permitted, on a case by case basis, in consultation with Federal, state, and NSB regulatory and resource agencies. Permitting facilities within the ¼-mile buffer of fish bearing lakes in the Deep Water Lakes Area could result in disturbance to eiders near the facilities and access roads. Although Lease Stipulation K-2 has been designed primarily to provide mitigation for deep-water fish habitat, it could also lessen impacts to eiders using habitats near these lakes.

Air Traffic

The types of effects to eiders from aircraft would be the same under Alternative B as those that would occur under Alternative A, and could include displacement from preferred feeding

habitats, temporary or permanent nest abandonment, and temporary or permanent displacement from molting or brood-rearing areas. However, some eiders could either remain in habitats located near aircraft activities or move to nearby habitats. Although there is evidence that molting and staging geese are disturbed by aircraft (Jensen 1990, Ward et al. 1999) and pre-nesting eiders may respond to low flying (≤ 150 feet) aircraft (Balogh 1997). Evidence of adverse impacts to eiders is equivocal. Johnson et al (2006) found no indication that spectacled eider nests with higher levels of overflights had reduced nest success compared to those with no or less overflights. Nevertheless, it is reasonable to assume that some level of effect may occur under certain circumstances. Repeated flushing of pre-nesting birds may reduce nesting success, more sensitive birds may not nest or be displaced to lower quality nesting habitat, and disturbance of molting eiders may result in greater rates of predation and reduced fitness with subsequent reduced migratory survival. None of these effects have been demonstrated, and would be very difficult to establish cause and effect relationships; however, here it is assumed that they are possible, but the magnitude (number of birds affected) and severity (likelihood of mortality/reduced recruitment) is unknown.

A greater number of eiders could be affected by air traffic under Alternative B than A, even though a larger area would be available for oil and gas leasing in the Goose Molting Area, and facilities could be located in the portions of the Teshekpuk Lake Caribou Habitat Area (where surface activity was prohibited under Alternative A), Lease Stipulations K-3 through K-6 would provide setbacks from various habitats surrounding Teshekpuk Lake and along the coast that are considered important for fish, birds, and caribou in the area. Within these setbacks, permanent oil and gas facilities would be prohibited, and other potentially disturbing activities, such as vehicular and air traffic, would be restricted. These lease stipulations would help to reduce potential aircraft disturbance to eiders, should oil and gas facilities be located within portions of the Teshekpuk Lake Special Area. However, if CPFs were located within the Teshekpuk Lake Special Area, the level of aircraft disturbance would likely increase along flight corridors and near airstrips located at these CPFs. Flight restrictions under Lease Stipulations K-4 and K-5 would be expected to also reduce the effects of aircraft in the Caribou Habitat Area/Goose Molting area.

Watercraft

Several types of watercraft could be used during the summer to transport equipment and supplies and to conduct oil spill response training drills. Summer barge traffic with the potential to temporarily displace molting eiders could occur in offshore waters of the planning area from mid-July through October. How eiders will react to boat traffic is unknown but the may react similarly to other waterfowl with short-term short-distance avoidance movements (Flint et al., 2003). Displaced eiders would probably move to adjacent habitats or return to original habitats after the barges passed though the area and barge traffic would not be expected to substantially impact molting eiders. There would be a greater likelihood for disturbance to molting eiders under Alternative B than under Alternative A because much of the area adjacent to the coast would be open for leasing under Alternative B but unavailable for oil and gas development under Alternative A. Therefore, it would be more likely that development would occur in portions of the Goose Molting Area, and that barge traffic would be required near this area for transportation of equipment and supplies during oil field construction and operation.

Oil spill response training activities using watercraft could be conducted on rivers and lakes several times during the summer open-water season. Under Alternative B, these activities would be more likely to disturb eiders than under Alternative A, because there would be a

greater likelihood that facilities would be located in areas of spectacled eider concentrations within the Goose Molting Area.

Habitat Loss and Alteration

Under the development scenario for Alternative B the gravel footprint for roads, pads, airstrips, staging areas and gravel extraction sites is estimated to be approximately 3,716 acres; approximately 12% more than under Alternative A. Loss of eider habitat would be greater under Alternative C and be permanent in the area occupied by the development footprint, and eiders nesting in this area would be displaced to other areas. Their survival and future reproductive success would be dependent on the availability and quality of unoccupied habitat.

If spectacled and Steller's eider densities are assumed to be 2.0 and 0.02 birds per mi^2 (640 acres per mi^2) respectively (very high estimates based on aerial survey data; Larned et al. 2006; Ritchie and King 2003), up to 11.7 spectacled eiders and 0.1 Steller's eider could be expected to be displaced by the gravel footprint over the life of the plan if all development occurred in high density areas. This estimate is likely overly-conservative as areas of "high high" density make up only a small proportion of the planning area even with the additional area north of Teshekpuk Lake being open under Alternative B (Map 3-33).

Alternative B would open a portion of the area north of Teshekpuk Lake closed under Alternative A. Average eider density over 15 years in area north of Teshekpuk Lake is 0.79/mi^2 This area also contains approximately 57% of the indicated population within the Northeast NPR-A planning area (FWS, unpublished data). When this area is included the average Northeast NPR-A spectacled eider density is 0.36 eiders/mi^2. For comparison average spectacled eider density in the entire Eider Breeding Survey Area is 0.57 eiders/mi^2 (Larned et al 2006). Steller's eider densities are so low that estimates are not calculated from the Eider Breeding Survey (Larned et al. 2006), but they do occur within the planning area.

However, under all alternatives, the potential effects of habitat loss would depend on the location of the development, the types of habitat lost, and the level of eider use in the areas to be developed. Without specific information on the locations of potential developments, the estimates of eiders potentially impacted should be seen as an index of comparison between alternatives, not an absolute value of birds affected.

In addition to permanent habitat loss, temporary loss of tundra habitat adjacent to gravel roads and pads could occur as a result of thermokarst, dust deposition, snow accumulation, and impoundment formation. Under Alternative B, the types of effects to eiders resulting from temporary habitat loss would be the same as those discussed under Alternative A. As with permanent habitat loss, the degree of effects would depend on the location of gravel infrastructure and local use of adjacent habitats by eiders. However, impacts from the temporary loss of tundra habitat are projected to be greater under Alternative B than A because more areas with higher densities of eiders are available for oil and gas leasing. Lease stipulations and ROPs, particularly E-11, would help to mitigate potential effects of habitat loss to eiders.

Mortality

Eider mortality could result from collisions with vehicular traffic, buildings, elevated pipelines, towers, boats, or bridges. The potential for collisions with oil field structures or equipment has been discussed under Alternative A. Compared to Alternative A, there would be an increased

risk that eiders would collide with offshore barge and vessel traffic under Alternative B, because of the greater potential number of barges and the possibility of barges coming ashore on the north coast of the planning area. Given that the highest concentrations of spectacled eiders in the planning area occur in this area, the siting of facilities within this area would increase the potential for eider mortality due to collisions with oil field structures or equipment, relative to Alternative A. Under Alternative B, ROP E-10 would require illumination to reduce the potential that migrating waterfowl would collide with drilling structures, production facilities, and other structures exceeding 20 feet in height. ROP E-11 would require that overhead lines and guywires be minimized and marked if it is not feasible or safe to bury them or place them in cable trays attached to VSMs. Although there is no similar action under Alternative A, the potential risk of eider mortality from collisions with oil field infrastructure could still be greater under Alternative B because the potential benefits of illumination of facilities might not be adequate to mitigate for the presence of facilities within or near areas of high eider concentrations.

Some predators, such as ravens, gulls, Arctic fox, and bears may be attracted to areas of human activity where they find anthropogenic sources of food and denning or nesting sites. The potential impacts of increased levels of predation on eiders resulting from increased numbers of predators that may be attracted to developed areas are discussed under Alternative A. The potential types of effects of increased predation to eiders under Alternative B would be the same as those discussed under Alternative A. Under Alternative B, impacts to eiders from predation are expected to be greater than impacts from Alternative A because more development is possible and more areas of high eider density are open for development. Although both Alternative A and Alternative B have lease stipulations in place to eliminate attraction of predators to anthropogenic sources of food, under Alternative B the lessee would be required to use the best available technology to prevent facilities from providing nesting, denning, or shelter sites for ravens, raptors, or foxes. There is no equivalent lease stipulation under Alternative A.

Effects of Abandonment and Rehabilitation

Winter activities would cause little disturbance or displacement, because eiders are absent from the area during the winter. However, ice roads could cause impoundments of water that could reduce habitat for nesting birds; such impacts would only affect nesting in the summer following ice road use. However, these impacts should be very minor since most ice roads have melted prior to the time of nest initiation. Summer road and air traffic generated by abandonment and rehabilitation activities could cause disturbance, displacement, and mortality to eiders similar to, and at the same levels as, those described for traffic during construction and operations. If pads, roads, and airstrips were not revegetated, they would remain lost habitat for eiders. If they were revegetated without removing the gravel, the habitat would not return to its current utility. If gravel was removed, habitat similar to that currently existing in the area could be created and used by eiders, though the precise mix of habitat types would likely not be the same as what was in the area prior to disturbance. The potential for adverse effects from abandonment and rehabilitation is greater under this alternative compared to Alternative A and proportional to the differences in construction effects between the two alternatives.

Effects of Spills

Oil spills would have similar types of effects to threatened eiders under Alternative A and Alternative B. However, there would be an increased risk of a contaminant spill occurring

under Alternative B. The potential for an offshore spill would increase because there would be approximately 20% more barge traffic under Alternative B than Alternative A. The risk of an onshore spill risk increases with increased volume of oil expected to be produced. The risk (or number of) large spills under Alternative B increases by about 15% (0.3 spill – see **section 4.2.2 – Oil Spills)** and the potential spill from large spills increases by 1,622 barrels compared to Alternative A. In addition, a pipeline leak or other spill in the Teshekpuk Lake Special Area could affect eiders under Alternative B; this area would be closed to leasing under Alternative A. Under Alternative B, Lease Stipulations K-1, K-2, K-3, K-4, and K-6 would provide setbacks ranging from approximate 0.25 mile to 3 miles from specified rivers, lakes, and the Beaufort Sea coast, within which permanent oil and gas facilities would be prohibited, to help reduce potential effects of an oil spill on eider habitats.

Oil entering rivers or streams could potentially spread into delta or coastal areas, where impacts to eiders could be more severe. Under Alternative B, Lease Stipulation K-1 would help to reduce the likelihood that an oil spill would enter a major river or stream. This lease stipulation would provide setbacks of ½ to 3 miles from specified rivers, within which permanent oil and gas facilities would be prohibited, although pipelines could be permitted in some of these areas. Alternative A has similar lease stipulations, except that the Tingmiaksiqvik River is included under Alternative B, but not under Alternative A.

Commercial Gas Development

Gas development would have impacts on eiders similar to that described for oil development, except that there would be no impacts from oil spills. Any effects of natural gas development and production on spectacled and Steller's eiders are expected to be limited to temporary, nonlethal effects, perhaps resulting in disturbance to a few birds. However, a natural gas well blowout occurring from June to September could affect eiders that are nesting, rearing young, staging, or migrating. Some mortality could result from such an incident, although it is likely that no more than a small number of individuals would be affected. Such impacts to eiders would be more likely in alternatives B, C, and D, which make important eider habitat available for leasing north and east of Teshekpuk Lake than Alternative A.

4.4.10-b.3 Effectiveness of Stipulations and Required Operating Procedures

Lease stipulations and ROPs would help prevent spilled fuel, oil, or other toxic materials from reaching the marine environment, thereby minimizing the potential for effects to molting or staging eiders. These measures would also protect habitat and help to minimize disturbance to eiders from oil and gas exploration and development activities. These measures should be equally, or more effective than the measures developed for Alternative A.

Numerous lease stipulations and ROPs were developed to mitigate impacts to birds and their habitat within the planning area. These include the "A" ROPs, which would be effective in ensuring that solid, liquid, and hazardous wastes did not impact birds or their habitats, and in reducing the potential for garbage to attract animals that may prey upon birds to exploration and development sites. The "B" ROPs would be effective in ensuring that water withdrawals do not impact lakes, or lake habitats, used by molting geese or threatened eiders, while the "C" ROPs govern seismic ground operations during spring and summer to prevent seismic activity-related disturbance to eiders during the nesting and molting periods. Disturbances caused by aircraft are controlled within the Goose Molting Area and raptor sites under ROP F and K-4 and K-5. Several of the "K" lease stipulations would help lessen impacts to eiders and their habitats by placing buffers around rivers and lakes ranging from ¼ mile around lake shores in

the Goose Molting Area and deep water lakes (Stipulation K-4 and K-2 respectively) to1/2 mile to 3 miles around major rivers (Stipulation K-1).

However, only ROP E-11 is specific to eiders. It requires pre-construction surveys for 3 years which will assist in facility and infrastructure placement to avoid eiders. It also requires minimizing overhead lines and guywires. Transmission lines are required to be attached to VSMs or buried off-pad and marking devices are required for guywires. These requirements substantially reduce the collision risk by limiting hard to detect overhead transmission wires and making guywires more visible.

4.4.10-b.4 Conclusion

Under Alternative B, the types of disturbances related to vehicle, aircraft, pedestrian, and vessel traffic, routine maintenance activities, heavy equipment use, facility noise, and oil spill clean-up activities would be the same as those that would occur under Alternative A. The potential for these disturbances to impact spectacled and Steller's eiders would be greater under Alternative B because a greater percentage of the planning area would be available for leasing, including portions of high eider use areas in the Teshekpuk Lake Special Area.

Alternative B predicts the potential for 12% more direct impact (446 acres) to tundra than Alternative A. Because the location of development is unknown, this difference should be seen as an index of likelihood of impact to eiders, not an absolute increase in impact. The potential for habitat loss and alteration to affect eiders would be greater under Alternative B than under Alternative A, In addition, there would be a greater potential for infrastructure to be located in areas of high eider use in the Teshekpuk Lake Special Area. The potential for eider mortality resulting from collisions with vehicles and/or infrastructure and marine vessel traffic would also be greater under this alternative than Alternative A. In general, impacts to eiders from non-oil and gas activities, and from oil and gas activities, would likely be additive. However, once exploration and development/production ceased in an area, bird populations and habitat could recover, reducing overall effects in the planning area. In areas where two or more activities occurred, overall impacts would reflect those impacts associated with the first activity and any new impacts associated with later activities. Because of the larger disturbance area, the potential for more oil and gas exploration and development activities, and increased barge traffic the potential for impacts to eiders under this alternative would be between 12 and 20% greater compared to Alternative A.

4.4.10-c Polar Bears

4.4.10-c.1 Activities Not Associated with Oil and Gas Development

Subsistence hunting and disturbance of denning bears resulting from winter overland travel likely have the most effect on bears in planning area. There is no record of where bears are taken, so the how subsistence take impacts bears in or near the planning area is unknown, but on average 32 polar bears from the Southern Beaufort Sea stock are taken annually in Alaska (Angliss and Outlaw, 2005). Winter overland travel not in support of oil and gas is likely relatively rare in the planning area and unlikely to result in significant disturbance effects. Research activities and close passes (<1 mile) may cause abandonment of a den if they occur early in the season but do not appear to have significant effects later in the season (Amstrup, 1993).

4.4.10-c.2 Oil and Gas Exploration and Development Activities

Seismic

Under Alternative B, a small number of polar bears could be affected by seismic exploration occurring along the coast, although ROP C-1 would prohibit seismic activities within one mile of known or suspected polar bear dens or seal birthing lairs. Since seismic effort is expected to be similar among alternatives, there should be no difference in potential impact.

Exploration

Under Alternative B, increased levels of exploratory drilling and development that could occur near the coast would increase the likelihood of displacing or attracting polar bears or causing den abandonment compared to Alternative A. Most polar bear dens near the planning area are off the coast, north of Teshekpuk Lake. The effects of exploration activities, including disturbance and potential spills, would depend on the scale and duration of the activity and could affect some polar bears.

Development and Production

Female polar bears denning within approximately 1 mile of construction activity could be disturbed by vehicle traffic and construction noise. If disturbance leads to premature abandonment of the den it could result in the potential death of cubs (Amstrup and Gardner, 1994). The required set-backs under Lease Stipulation K-1 and K-4 from major rivers and the coastline respectively would reduce the likelihood of construction destroying potential den sites. However, under Alternative B, impacts of polar bears from oil and gas production would likely be greater than Alternative A. Polar bears could be attracted to drill sites by food odors and curiosity, increasing the potential for negative human-bear interactions, and the possible death of bears in defense of human life and property. However, under current rules, policy, and practice there has not been a Defense of Life and Property (DLP) taking reported in the Alaska oil fields (Schliebe et al. 2006).

As under Alternative A, consultation between oil field developers and the USFWS would result in the use of nonlethal means of deterrence if necessary.

Contaminant Spill

Female polar bears select "bluffs" including river banks for denning habitat, thus they are more likely to be present in river drainages. Any spill that reached a river during late fall when polar bears are constructing dens, occurred in winter under ice, or in spring during broken ice periods could impact denning polar bears and their young if the spill was large enough to reach the den area in sufficient concentration.

Spring or summer spills that reached marine waters would have the greatest likelihood of impacting polar bears or their prey. Spills during broken ice or in the lead system would have the largest potential for adverse effect.

Polar bears are generally widely dispersed, thus any spill would be unlikely to affect more than one to three bears unless a very large spill occurred.

Effects of Abandonment and Rehabilitation

Effects would generally be the same as under construction and proportionally greater than Alternative A. Dismantling of equipment and modules and readying it for transport would most likely take place during summer. Transport of large or heavy material would be a winter activity and occur over ice roads. Any re-contouring or removal of gravel would primarily be done in the winter, although some summer activity may be necessary to finish. Any planting or monitoring would also be a summer activity. A combination of surface vehicles and aircraft would be required for transportation. The potential for large spills would be substantially reduced after shut-down.

Commercial Gas Development

If natural gas development and production occur in the coastal areas used by polar bears, potential impacts would include those described above for oil development, such as attraction to waste from the facilities, though there would be no oil spill impacts. Denning female bears may be encountered during winter construction or maintenance activities. Aroused female bears may abandon the den, potentially leaving cubs. Additionally, increased energy expenditure could negatively impact the cub survival. Because more lands near the coast would be available for oil and gas development under this alternative than in Alternative A and because more development is likely to occur, there is greater potential for impacts to polar bears than under Alternative A.

4.4.10-c.3 Effectiveness of Stipulations and Required Operating Procedures

ROP A-1 would minimize the potential for food waste to attract polar bears and the need for deterrence or take. The ROP is similar to current practice within the Prudhoe oil fields which has resulted in few deterrence actions and no DLP takings since implemented (Schliebe et al. 2006).

Required Operating Procedure C-1 would prohibit the cross-country use of heavy equipment and seismic activities within 1 mile of known or observed polar bear dens or seal birthing lairs. This ROP would also require operators to consult with the USFWS before initiating activities in coastal habitat between October 30 and April 15. Letters of Authorization reinforce the ROP and may result in area specific restriction that would further reduce the likelihood of adverse affect.

The K-1 Lease Stipulation would require 0.5-3 mile setbacks from the major rivers the planning area. This is expected to reduce the potential for disturbing denning bears in these areas. Pipelines could still cross these areas so the likelihood of a spill from a transport pipeline entering a river would not be affected, but spills from accidents on pads or at compressor stations would be very unlikely to reach the river banks.

Lease Stipulation K-6 would prohibit the placement of permanent facilities within ¾ mile of the coast, except where technological limitations, economics, logistics, or other factors necessitated a structure. Under these circumstances, the use of a previously occupied site (Camp Lonely, Husky/USGS drill sites, and DEW-Line sites) would be considered. The elimination of new permanent facilities within ¾ mile of the coast should be effective in reducing the potential for disturbance to polar bears and their prey and is expected to reduce the potential for disturbance (displacement or attraction) of polar bears along the coast.

4.4.10-c.4 Conclusion

Under Alternative B, ROPs and lease stipulations (as described under "Effectiveness of Stipulations and Required Operating Procedures") would prohibit the construction of permanent structures within ¾ of a mile of the coast, although exploration could occur in the area. The effects of exploration activities, including disturbance and spills, would be localized and would be unlikely to affect populations. Individual polar bears could be affected by exploration activities and seismic surveys in close proximity to polar bear dens and could cause abandonment of maternity dens by polar bears. Avoidance requirements are expected to result in only a small number of dens being affected.

Under Alternative B, impacts to polar bears and their habitat from oil and gas activities would be greater compared to Alternative A because a greater area would be available for leasing and development, and more area is expected to be converted to gravel. The partial opening of the area north of Teshekpuk Lake would allow development in areas where polar bears are most likely to occur; however, coastal buffer and river buffer requirements should reduce the potential for adverse effects. The ROPs and Stipulations combined with the relative low density of denning bears near the planning area make it unlikely that Alternative B would have a significant effect on polar bear populations.

4.4.11 Cultural Resources

4.4.11.1 Activities Not Associated With Oil and Gas Exploration and Development

Aircraft and watercraft traffic, scientific investigations (e.g., archaeological and paleontological surveys and excavation), summer camps, hazardous and solid waste material removal and remediation, overland moves, and recreation could cause effects to cultural resources. The effects of these non-oil and gas activities on cultural resources under Alternative B would be the same as those occurring under Alternative A. There would be no difference in recreational use between Alternative A and Alternative B. However, a greater amount of scientific work could occur in the planning area under Alternative B as well as other management activities by BLM, as a larger area would be made available for oil and gas development. As a result, there would be a greater likelihood of effects to cultural resources in the planning area under Alternative B than under Alternative A.

4.4.11.2 Oil and Gas Exploration and Development Activities

Under Alternative B, the amount of area available for exploration along a geological feature known as the Barrow Arch, which is anticipated to hold significant deposits of hydrocarbons, would be greater than under Alternative A as would the amount of land anticipated to receive surface impacts. This area is also a key subsistence resource area noted for caribou and birds, and may have a high number of undocumented archaeological and historical sites, in addition to the documented cultural resources in the area. The risk of damage to known and undocumented cultural resources would increase with the greater level of activity in the region occurring under Alternative B due to the additional approximately 387,000 acres being made available for leasing.

Effects of Disturbances

Under Alternative B, the level of disturbance associated with oil and gas exploration and development activities in the planning area would be higher than Alternative A due to the greater acreage available for leasing. However, because most activities would occur during the winter months, the potential for effects to buried cultural resources would be minor. As discussed for Alternative A, the likelihood of surface disturbance affecting surface cultural resources would be minor because of their isolated occurrence and because of the variety of lease stipulations and ROPs that would govern oil and gas exploration activities. At staging sites such as Camp Lonely and Inigok, where potentially ground-disturbing activities occur year-round, the greater intensity and duration of these activities occurring under Alternative B would likely have a greater risk of affecting known and undocumented cultural resources.

Under Alternative B, the types of effects of possible disturbance would be the same as those occurring under Alternative A. Efforts to supply necessary materials for construction of gravel pads, airfields, and roads at this scale could increase the likelihood of damage to known or undocumented cultural resources in the planning area. The excavation of gravel material for the construction of the permanent facilities would be the primary source of potential effects to cultural resources. Pipelines would not have associated all-weather gravel roads or pads and would be constructed during the winter months from an ice road and pads. The only effects on cultural resources resulting from aboveground pipeline construction would be associated with the placement of VSMs, and would depend on the depth at which the VSMs were set.

Effects of Abandonment and Rehabilitation

It is unlikely that cultural resources would be impacted by abandonment activities unless the facilities to be abandoned or removed during rehabilitation were themselves historic.

Effects of Spills

Under Alternative B, the effects of oil spills on cultural resources would be the same as those that would occur under Alternative A, though because there is an increased chance for more spills and more spilt oil, there would be a corresponding marginal increase in the potential impacts to cultural resources. In the exploration stage, most spills would occur on an ice pad or ice road and during winter conditions. In such a case, the spill or subsequent spill cleanup would probably not alter or destroy buried cultural resources, but could affect surface cultural resources by covering these resources with oil or other spill material. Warm oil, however, could melt through the snow and ice and impact cultural resources buried near the surface. A spill occurring during the summer would have a greater potential to affect surface and subsurface cultural resource sites than a spill occurring during the winter because the effects of both the spill and subsequent cleanup would be greater. Oil spills on cultural resource sites would cause damage proportional to the extent of contamination, and could require data recovery (excavation) as part of remediation and clean-up efforts as irreparable damage to some of the data could occur. Oil spills at cultural resource sites, either at the surface or buried, would make radiocarbon dating of that site problematic or impossible. The spilled oil would seep into organic materials used for radiocarbon dating such as charcoal, bone, and wood and contaminate them so that their radiocarbon dates could be inaccurate.

Commercial Gas Development

The types of impacts on cultural resources that natural gas development and production would cause would be the same as those caused by oil development described above, except that there would be no crude-oil spills, impact from creation of gravel pads would be increased for a 10- to 20-acre pad for a pipeline compressor station, and if a gas pipeline is buried—the likely method—there would be additional acreage disturbed with increased potential for disturbance or destruction of cultural resources. As with Alternative A, it is anticipated that burying the pipeline would result in digging up approximately 162 miles of four feet wide and five feet deep trench (approximately 80 acres) and potential surface disturbance of 210 acres in areas adjacent to the trench from potential disturbance from machinery or placement of backfill. The risk to cultural resources would be reduced dramatically if gas pipelines are put on VSMs.

4.4.11.3 Effectiveness of Stipulations and Required Operating Procedures

Under Alternative B, several lease stipulations and ROPs would minimize the effects of oil exploration and development activities on cultural resources. Required Operating Procedure E-13, which corresponds to Lease Stipulation 74 of Alternative A, calls for a survey of resources prior to any ground disturbing activity. Required Operating Procedure I-1, which corresponds to Lease Stipulation 63 of Alternative A, would be effective in reducing cultural and resource conflicts through an orientation program for personnel that would teach the importance of not disturbing archaeological resources, as well as sensitivity to community values, customs, and lifestyles. The "K" lease stipulations would require setbacks along rivers, streams, lakes, cabins, and the coast, providing effective protection to cultural resources in these areas. Lease Stipulations K-1, K-2, K-3 and K-7, which correspond to Lease Stipulations 24, 39, and 62 of Alternative A, would effectively minimize the loss of cultural resources through setbacks from certain rivers, lakes, and areas where concentrations of subsistence cabins and campsites occur. Prior to any undertaking (i.e., ground-disturbing activities such as the construction of buried pipelines) on Federal lands, the NHPA would require that an archaeological resource survey be completed. If cultural resources were identified during such a survey, BLM guidelines and policy would require that all impacts to these resources be mitigated to the satisfaction of the land manager and the State Historic Preservation Officer.

4.4.11.4 Conclusion

The probability of impacts would increase under this alternative as compared to Alternative A because of the increase in the amount of land that could be impacted. Effects to cultural resources from oil and gas activities could occur in leased areas of the planning area and would continue for the duration of operations through abandonment. Known cultural resources would not be affected, but the presence of undocumented cultural resources in the planning area cannot be discounted. Multiple sales over the available portions of the planning area increase the likelihood of effects to undocumented cultural resources.

Approximately 2 to 3% of the planning area has been surveyed for cultural resources. The distribution of known cultural sites does not reflect locational preference of prehistoric and historic people, but rather indicates that only portions of the planning area (e.g., well sites, portions of the coast, the Colville River, the Ikpikpuk River, and the Teshekpuk Lake area) have been examined through some type of organized reconnaissance for the presence of cultural sites. The TLUI sites generally cluster in these same areas with greater density on the lower Ikpikpuk River and associated drainages (NSB 1978, 2003). Activities that occur near these areas may have a greater likelihood of impacting cultural resources.

In general, impacts to cultural resources from non-oil and gas activities, and from oil and gas activities, would likely be additive, except in those areas where the two types of activities overlapped. Impacts to resources from exploration and development activities would also be additive, except where development activities occurred in areas previously disturbed during exploration. In areas where two or more activities occurred, overall impacts would reflect those impacts associated with the first activity and any new impacts associated with later activities. Because of the larger disturbance area and the potential for more oil and gas exploration and development activities, potential impacts to cultural resources under this alternative would be greater for oil and gas exploration and development activities, as compared to Alternative A. Impacts could be greater, however, if oil and gas exploration and development activities occur in an area with a high concentration of cultural resources. These impacts would be effectively mitigated by lease stipulations and ROPs that prohibit oil and gas exploration and development in areas with a high likelihood of having cultural resources, enforcement of lease stipulations and ROPs that prohibit collection of artifacts and require training of workers regarding avoidance of effects on cultural resources, and compliance with all Federal laws, including the National Historic Preservation Act, requiring surveys for cultural resources in areas where ground-disturbing activities are proposed.

4.4.12 Subsistence

4.4.12.1 Activities Not Associated With Oil and Gas Exploration and Development

Under Alternative B, non-oil and gas-related activities requiring permits from the AO would be subject to the stipulations outlined in Appendix E as well as any other applicable Federal, state, and NSB regulations. Activities not associated with oil and gas exploration and development include: aircraft and watercraft use; research activities, including remote camps associated with research; overland moves; and recreation. All of these activities have the potential to affect subsistence use. See **section 4.1** for a detailed description of the types of non-oil and gas activities that may occur in the planning area.

Effects of Disturbances

Aircraft Use. Under Alternative B, the opening of areas to the north and west of Teshekpuk Lake could increase the amount of aircraft use, especially with regard to surveying resources and conducting studies. The effects would be similar to those under Alternative A, however they would be greater in number, and could disturb subsistence harvesters in the area of the activity. Aircraft could divert migrating or insect-avoiding caribou, as well as seals, walrus, and whales from subsistence use areas. Subsistence users have repeatedly stated during scoping meetings that aircraft traffic reduces harvest access and success (Nukapigak 1998, Ahtuangaruak 2003, Kaigelak 2003, Olemaun 2003).

Watercraft Use. Under Alternative B, the effects of watercraft on subsistence harvest patterns would be the same as those discussed under the Alternative A.

Research Activities. As baseline data are gathered preparatory to further lease sales under Alternative B, scientific research (biological, archaeological, paleontological, and geological) and data collection could increase as compared to Alternative A. The effects would be similar to those under Alternative A, however they would be longer in duration and greater in scope. Biological research and monitoring would increase to expand baseline data for future

monitoring of effects. Archaeological, paleontological, and geological activities involving personnel walking on tundra would have some short-term effects on subsistence species and possibly on harvest. The result of increased research and data collection would be temporary and localized diversion, deflection, or disturbance of subsistence species, including caribou, moose, grizzly bear, polar bear, wolf, wolverine, muskox, and spotted seals (USDOI BLM 2003). Therefore, there would be an increased likelihood that these activities would affect subsistence harvest success. Research activities would predominately take place in the summer months. Aircraft-based biological surveys would have the greatest likelihood of affecting subsistence harvest patterns because they cover a large area, last a long time relative to other research activities, and are known to elicit responses from caribou and waterfowl.

Recreation. Under Alternative B, more recreation could occur in the planning area in response to publicity, but it would likely be limited to summer use of river corridors and existing areas. The effects would be similar to those under the Alternative A, however there could be increases in user conflicts and greater effect to subsistence resources along highly utilized rivers, such as the Colville. Recreational users would likely frequent waterways used by subsistence hunters during the summer months, potentially causing resource user conflicts. The effects of these conflicts on subsistence harvest patterns would likely be localized and of short duration. Recreation would result in a temporary and local effect on subsistence species.

Solid and Hazardous Waste Removal and Remediation. Solid and hazardous waste removal and remediation, such as monitoring of existing clean-up sites and aging infrastructure (e.g., wellheads), would be ongoing and independent of additional lease availability. As discussed under Alternative A, solid and hazardous waste removal and remediation activities would have localized effects that would last for the duration of the activity. The effect of solid and hazardous waste removal and remediation on subsistence species under Alternative B would be similar to those that would occur under Alternative A. Over the short term, a localized deflection of subsistence species could occur. Long-term effects could include a decreased potential for contamination of subsistence species with the cleanup of waste sites. Evaluation activities would have little effect on long-term harvest patterns. Site cleanup and remediation activities could temporarily divert or disturb caribou, muskox, and grizzly and polar bears, but would have little effect on long-term subsistence harvest patterns.

Overland Moves. Under Alternative B, the number of overland moves would be comparable to those anticipated under Alternative A. Overland moves would occur only by permit and would be subject to lease stipulations and ROPs. Overall, the effects would be similar to those described under Alternative A, consisting of temporary and localized displacement of resources from the authorized right-of-way.

Conclusion

The effects of non-oil and gas activities on subsistence species would be similar to those that would occur under Alternative A. Activities would be, in most cases, of limited duration and magnitude, and effects on subsistence would be limited to the immediate area of the activity. Under Alternative B, aircraft and watercraft traffic could increase during summer to support scientific research that would be required prior to expanding lease areas, resulting in an increased impact to subsistence species through temporary and localized diversion, deflection, or disturbance of animals.

As discussed under Alternative A, these activities could alter the availability of subsistence species in traditional harvest areas through direct interference with hunts. This direct

interference could affect harvest patterns by causing a failed hunt, or by requiring hunters to travel further for a successful harvest because the subsistence resources are more wary than normal following a disturbance or are deflected from traditional harvest areas following the presence of vehicles, vessels, and aircraft. Nuiqsut residents have noted that aircraft have diverted subsistence resources away from areas where hunters were actively pursuing them, directly interfering with harvests or causing harvests to fail (USDOI BLM 2004C). Increased travel distances would result in greater expenditures for fuel and equipment, as wear and tear on snowmobiles, outboards, and four-wheel vehicles would occur.

4.4.12.2 Oil and Gas Exploration and Development Activities

Alternative B would make available approximately 95% (4,387,000 acres) of the planning area's approximately 4.6 million acres for oil and gas leasing. Management practices would emphasize performance-based stipulations and ROPs on surface activities, consultation with local residents, and coordinated scientific studies to protect wildlife habitat, subsistence use areas, and other resources. In addition, approximately 213,000 acres located northeast of Teshekpuk Lake would be unavailable for oil and gas leasing, to provide for protection of wildlife and subsistence resources.

Effects of Disturbances

Seismic Survey Activity. Under all alternatives, it is anticipated that five additional seismic surveys, three 2-D and two 3-D, would be conducted within the planning area in order to cover all gaps where seismic has not yet occurred. The three 2-D surveys are projected to potentially impact a total of 8,126 acres, which is the combined total of acres impacted by the survey and acres impacted by the camp train overland move. The two 3-D surveys are estimated to potentially impact a total of 99,870 acres, combined. It is also assumed that the surveys would occur in those areas currently not surveyed, namely Teshekpuk Lake, the area north of the lake, and the foothills region in the south. The effects of seismic exploration would be the same as those described under Alternative A (see **section 4.3.12.2**).

Exploratory Drilling. Under Alternative B, it is estimated that 97 exploratory wells will be drilled in the planning area, with an additional 73 delineation wells drilled in subsequent years near wells that showed potential as oil producers. This is an increase of 11 exploration wells, and 8 delineation wells from Alternative A. Wells that do not indicate the presence of hydrocarbons in developable quantities will be plugged and abandoned. Wells that show potential may be "suspended," and capped with what is known as a "Christmas tree" at the surface. It is anticipated that at most, six drill rigs will be operating in the planning area in any given winter season, an increase of one rig under this alternative.

Impacts as a result of exploratory drilling under Alternative B will be identical to those described under Alternative A; however, given the increase in proposed activity, the effects on subsistence use would be greater in magnitude, extent, and duration. In addition, the opening of a portion of the areas around Teshekpuk Lake to exploratory drilling increases the number of necessary studies to be conducted prior to the winter drilling season. These studies include lake characterizations (volume and fish species present) for water withdrawal and cultural resource surveys along proposed access routes and at all drill pad locations. Staking surveys will also need to be conducted by BLM at all permitted drill sites. All of these studies and surveys will be conducted in the summer, most likely with the use of helicopters for access.

Stipulation K-5 specifies flight restrictions over caribou (over 1,000 ft AGL from Oct 1-May 1 in the TCH winter range; over 2,000 ft AGL from May 20-Aug 20 in the TLCHA) that must be followed unless doing so would endanger human life or violate safe flying practices. Despite the protection offered by Stipulation K-5, caribou utilizing the TLCHA could be affected by the increase in aircraft activity anticipated under Alternative B. Additionally, the area west of Teshekpuk Lake is utilized by subsistence fishers and caribou hunters from Barrow, and the Kogru River area east of Teshekpuk Lake is utilized by fishers and waterfowl hunters from Nuiqsut. Any activity in these areas has the potential to affect subsistence users and harvest patterns. For example, given the flight restrictions described above, companies may wait until after August 20 to conduct the necessary studies, resulting in a concentrated period of helicopter use during the fall. This is also the period of greatest harvest of caribou from the area west of Teshekpuk Lake by Barrow residents. As a result, this possible helicopter activity could result in user conflicts, and may lead to the abandonment of the harvest area.

Development and Permanent Facilities. Under Alternative B, it is estimated that there will be a need for six central processing facilities (90 acres each) in the planning area. In conjunction with these facilities there are other support structures, such as gravel production pads, gravel runways in-field gravel roads, several types of pipelines, and other associated structures, that will also cause surface disturbances. It is estimated that under Alternative B, there will be: 25 gravel production pads (10 acres each); 6 gravel runways (11 acres each); 250 miles of in-field gravel roads (7.75 acres/mile); 250 miles of three-phase produced fluids (oil, gas, water) gathering lines; 162 miles of sales oil pipelines; 6 pump stations (20 acres each); 3 staging bases (50 acres each); and 13 gravel pits (50 acres each). It is estimated that during the construction phase of these facilities that the total disturbance would be 4,965 acres. Construction of the permanent facilities will primarily take place during the winter, using ice roads and pads in the area of development to move and stage machinery, supplies, personnel and housing. It is estimated that construction for a typical development would take a minimum of 3-6 years. During this construction phase, it is estimated that there would be an average of approximately 115-160 one-way aircraft flights per month during the winter, and 70-90 one-way operational flights per month during the summer. Construction activities could result in an economic boon to local communities, and could directly affect harvesters if they were hired by the companies. This increase in income could offset the increased cost of fuel needed to harvest displaced resources, but might also lead to a corresponding decrease in the amount of time a harvester could be out on the land depending on the work schedule (see **sections 4.4.13.2 and 4.4.18.2** for further discussion on economic impacts).

Under Alternative B, oil and gas activities would occur over a wider area than under Alternative A and could inhibit subsistence users from harvesting in their traditional use areas to a greater degree. Subsistence users tend to avoid areas of oil infrastructure and activity for the reasons noted under Alternative A. Hunters from Barrow and Atqasuk would be affected by development north and west of Teshekpuk Lake, where numerous subsistence camps, cabins, and ice cellars are located. As described under Alternative A, hunters avoid development areas, resulting in a shifting of subsistence use areas away from permanent facilities including pipelines and roads. Nuiqsut subsistence users have stated during scoping meetings and public testimony that air traffic reduces harvest success. Development within the areas north and west of Teshekpuk Lake would increase the amount of aircraft disturbance to subsistence species, as compared to Alternative A.

As discussed in **section 3.4.2, *Subsistence***, Nuiqsut, Barrow, Atqasuk, and Anaktuvuk Pass depend on TLH caribou as a subsistence species. If oil and gas development activities such as the construction of permanent facilities were to deflect, divert, or reduce the TLH caribou

population, harvest of caribou by area residents could be reduced until the caribou were able to habituate to the increased activity and infrastructure in the area. Oil and gas activities in the northeast portion of the planning area could affect Nuiqsut subsistence and activities, deflecting migrating caribou away from traditional harvest locations, reducing harvest access and success. If TLH caribou were to move outside of their normal migration routes, Anaktuvuk Pass could suffer a shortage of caribou, its main subsistence resource, until the normal migration route was resumed. A greater expenditure and risk on the part of the subsistence hunters from Anaktuvuk Pass would be required. In the past, when the herd has failed to pass near the community, hunters had to fly to other locations in search of subsistence food, increasing community stress and the time necessary for harvest success, as well as reducing the connection with traditional areas (SRBA 2003b).

Nuiqsut, Barrow, and Atqasuk subsistence users harvest wolves and wolverines in the planning area. These species could be displaced by further development in the area (Brower 1997). Alternative B would have a greater effect on subsistence caribou harvests than Alternative A because the areas of potential activity would be larger, the duration of oil and gas activity in the area (approximately 40 years) would be longer, and the geographical extent of possible development (from the Colville River to the Ikpikpuk River) would be greater.

Waterfowl could be affected by activity in newly opened areas during construction, development, and production. Helicopter traffic and persons walking on tundra or gravel pads would be the most likely sources of disturbance to nesting and molting waterfowl (USDOI BLM and MMS 2003). Increases in predator populations near developed areas could cause locally severe nesting failures (Burgess 2000, Johnson 2000b). However, these effects should be relatively minor, geographically widespread, and occur during the relatively brief period when these animals are present in the area. Some aspects of oil and gas development could create new habitat favorable to waterfowl survival, such as reclaimed gravel pits and water impoundments near roads (Johnson 2000a,b; McKendrick 2000; Ritchie and King 2000; Sedinger and Stickney 2000). A possible indirect effect of development in the Teshekpuk Lake area would be the placement of restrictions on harvests of waterfowl on the North Slope, the Y-K Delta areas, and along the Pacific Flyway (USDOI BLM and MMS 1998), in response to reduced waterfowl populations. These restrictions would reduce subsistence harvests.

Subsistence fish harvests take place in all seasons, primarily in freshwater rivers and lakes. Nuiqsut's primary harvest area for fish is located in the northeast quarter of the planning area, in the Colville River and its delta channels and near Fish and Judy creeks, where development is already in the planning stages. A loss or reduction in Nuiqsut's fish harvest would be a hardship for the community, as fish provide approximately 30-40% of all subsistence harvest by weight in the community. Barrow residents harvest fish during caribou harvest activities along the coast and in the Teshekpuk Lake and Chipp and Ikpikpuk rivers areas. Atqasuk residents fish in several lakes near Teshekpuk Lake and in the Chipp and Ikpikpuk rivers. Under Alternative B, development activities could impact fish and caribou harvest patterns; however, the lease stipulations and ROPs should be effective in protecting these resources to ensure subsistence harvests. Therefore, effects of Alternative B on subsistence fishing would not be much greater than the Alternative A.

As noted for Alternative A, oil and gas development could inhibit subsistence harvesters' use of the traditional harvest areas, which could reduce harvest success; increase the cost, effort, and risk involved with subsistence harvest; and increase the wear and tear on equipment for harvesting subsistence foods. The communities of Nuiqsut, Barrow and Atqasuk could all be

directly affected by development activities in the opened portions of the TLCHA under Alternative B.

Effects of Abandonment and Rehabilitation

During oil facility abandonment and rehabilitation activities, which include the removal of all equipment and facilities, and the plugging of all wells, subsistence resources and activities would be subject to impacts similar to those caused by construction as described under Alternative A (see **section 4.3.12.2**). Following the abandonment and rehabilitation, subsistence resources would be subject to fewer impacts. If the gravel roads and pads were left in place and remained serviceable, they could be used by residents to provide access to subsistence resources, possibly reducing hunting effort and time.

Effects of Spills

Under Alternative B, it is assumed that 2.513 large spills (e.g., greater than or equal to 500 barrels of oil, but less than 120,000 barrels) consisting of an estimated total of 12,062 barrels of oil, could occur in the planning area. These spills would consist of unrefined crude oil from a pipeline, or possibly as much as 900 barrels of crude or diesel oil from a gravel pad facility. Small spills (e.g., less than 500 barrels) are currently the most frequently-occurring spill type on the North Slope, and primarily consist of the release of less than a barrel of aviation fuel, diesel fuel, engine lube oil, fuels oil, gasoline, grease, hydraulic oil, transformer oil and transmission oil. Under Alternative B it is estimated that a total of 596 small crude oil spills and 1,788 refined oil spills could occur in the planning area. A very-large spill, defined as greater than 120,000 barrels of oil, is considered extremely unlikely to occur within the lifetime of this plan.

As discussed under Alternative A, the magnitude of the effects of a crude oil spill on subsistence resources would depend on the context of the spill, the area covered by spilled product, and the amount of time the product was in the environment before clean-up efforts commenced. Oil spills on snow or frozen tundra would be typically contained and cleaned up relatively quickly, regardless of the area covered. It might be impossible to completely clean oil spills that have spilled into waterways, especially during open water or broken ice conditions (USDOI BLM 2003). As there would potentially be more oil and gas activity occurring over a larger area under Alternative B than under Alternative A, the likelihood that oil spills would affect subsistence species would be greater.

Crude oil spills could affect caribou and waterfowl populations if the oil were on the ground and over a large area. This type of event has occurred even at natural seeps at Cape Simpson and Fish Creek (Ebbley and Joesting 1943). It is likely that only a very large spill on land would have population level effects on terrestrial mammals and waterfowl. In the case of a small or large spill that did not enter waterways, the effects would be localized, although contamination could last several years (USDOI BLM 2003). Tundra vegetation could also be contaminated by oil spills, which could harm mammals eating the oiled vegetation or using it for nesting or bedding.

If oil were to be spilled in waterways in large volumes, waterfowl, fish, and marine mammals could be fouled, contaminated, or killed. In the case of a large spill, the effects could spread beyond the immediate vicinity of the spill, depending on the season. For example, during ice breakup, sheet flow could carry oil over a vast area, which could include nearshore and offshore waters. Small and large spills would not necessarily be immediately toxic to fish, but could contaminate them for years even in cleaned habitats (USDOI BLM 2003). Waterfowl and

marine mammal populations could be affected by the death of animals from hypothermia caused by oiling, reactions to toxic components of spilled oil, and gastric distress resulting from attempts to clean themselves. In addition, scavengers feeding on their remains, such as foxes, could also be harmed.

Large spills could affect subsistence patterns by reducing populations of subsistence species, contaminating subsistence species or their habitats, or rendering resources as unfit to eat. These effects could reduce the amount of subsistence foods harvested, cause changes in traditional diets, increase risks and wear and tear on equipment if users were required to travel farther to obtain subsistence resources, and cause social stress due to the reduction or loss of preferred foods harvested in the traditional fashion. Effects on subsistence harvest patterns would be greater under Alternative B than under Alternative A, because oil and gas activity would likely occur over a larger area and the likelihood of an oil spill occurring would be greater.

Commercial Gas Development

Effects on subsistence resources and harvest patterns from natural gas development and production under Alternative B would occur in much the same way as effects would occur under that alternative from oil development and production, though there would be no crude oil spills from gas production. Because Alternative B makes important subsistence resource habitat and subsistence use areas available for leasing and development, this alternative would likely result in greater impacts to subsistence than Alternative A. Winter burial of the pipeline would potentially disrupt caribou and subsistence hunters, though once buried, a gas pipeline should not have additional impacts on subsistence. If a natural gas well blowout occurred, the subsistence harvest of any species in the vicinity could be affected and, if an explosion and fire occurred, subsistence resources in the immediate vicinity could be killed. Natural gas and condensates that did not burn in the blowout would be hazardous to any organism exposed in high concentrations. However, natural gas vapors and condensates would be dispersed very rapidly from the blowout site (1 km downwind for about 1 day) and would affect only those species in the immediate vicinity of the accident. While such an effect would be relatively short term and localized and likely would not measurably affect the regional population of any species, it could cause disruption to subsistence harvests in the area of the blowout. In addition, subsistence hunters, who already tend to avoid oil field infrastructure, may be even more likely to avoid gas fields for fear of a well blowout.

Conclusion

Under Alternative B, disturbances associated with oil and gas development would be the similar to those discussed under Alternative A. Areas that would be unavailable for year-round occupation and development under Alternative A would become available, and could be affected by oil and gas exploration activities. Should development proceed under Alternative B, the duration, severity, and extent of the effects of oil and gas development activities on subsistence species could be greater than under Alternative A, as there would be a larger area open for year-round occupation and development, which include ecologically sensitive areas. In addition, development in the area west and northwest of Teshekpuk Lake could affect subsistence users from Barrow and Atqasuk who utilize camps and cabins there. The amount of habitat loss and degradation would be greater under Alternative B than under Alternative A. Oil and gas activities could divert caribou and waterfowl from normal habitat areas and deflect these species from normal migration routes until they were able to habituate to activities and infrastructure changes in these areas. Caribou might prefer certain habitats during times of

nutritional or energy stress deflecting or diverting caribou from normal migration routes could lead increased stress and mortality. Increases in fox populations associated with human activities could result in an increased risk for predation of molting geese. Changes in overwintering and seasonal fish habitat caused by oil development (e.g., turbidity, salinity changes, reduced dissolved oxygen, and possible spills) could harm fish populations. Some species, (e.g., wolves and wolverines) would avoid human activity, while others (e.g., bears and foxes) would be curious and could become nuisance animals.

As discussed under Alternative A, these activities could alter the availability of subsistence species in traditional harvest areas through direct interference with hunts. This direct interference could affect harvest patterns by causing a failed hunt, or by requiring hunters to travel further for a successful harvest because the subsistence resources are more wary than normal following a disturbance or are deflected from traditional harvest areas following the presence of vehicles, vessels, and aircraft. Increased travel distances would result in greater expenditures for fuel and equipment, as wear and tear on snowmobiles, outboards, and four-wheel vehicles would occur.

4.4.12.3 Effectiveness of Stipulations and Required Operating Procedures

The performance-based lease stipulations and ROPs are intended to protect subsistence resources to the same extent, and potentially better, as the 1998 Northeast IAP/EIS ROD prescriptive lease stipulations under Alternative A. Under Alternative B, oil exploration and development would be allowed over a wider area and in more sensitive areas and habitats than under Alternative A; however, ROPs (e.g., ROPs H-1 and H-2) would be effective in minimizing conflicts between subsistence uses and oil and gas-related activities. During scoping, subsistence users stated that the proposed revision to the 1998 Northeast IAP is a breach of faith and that opening up more areas in the planning area would have severe negative effects on subsistence users from Barrow and Nuiqsut (Ahmaogak 2003).

Local municipal government and tribal governments generally have few paid staff and limited funding. Local government official and tribal leaders feel they are overtaxed when asked to provide meaningful input to BLM on permitted activities. These officials and leaders contend that the change from the prescriptive lease stipulations in the 1998 IAP to performance-based ROPs and lease stipulations similar to those in the Northwest IAP/EIS ROD would place them in the position of having to defend subsistence interests, because compliance is now defined in terms of meeting a management objective rather than meeting an absolute prescriptive standard. To effectively respond, they would have to further stretch their existing capabilities to review and comment on increasingly numerous industry proposals and their impact on subsistence.

BLM holds that performance-based lease stipulations and ROPs would provide equivalent protection, while gaining flexibility for adaptive management. The flexibility of the new approach places greater reliance on on-going monitoring to insure that these procedures do in fact achieve equivalent protections. BLM is committed to directing the necessary resources to this on-going monitoring requirement, including support for the continuing work of the Subsistence Advisory Panel to provide oversight, exchange information, and develop solutions for any emerging issues.

Effectiveness on Subsistence Species

Under Alternative B, several ROPs and lease stipulations would address subsistence species. Required Operating Procedures A-2 and A-8 would be effective in seeking to avoid human-caused changes in predator populations (i.e., avoid attracting wildlife to food and garbage). Required Operating Procedures A-4 to A-7 would be effective in minimizing the impact of contaminants (spills) on wildlife and the environment and to protect subsistence resources. Required Operating Procedures B-1 and B-2 would be effective in maintaining populations of and habitat for fish and invertebrates.

Required Operating Procedure C-1 would be effective in protecting bear denning and birthing sites during overland moves. Required Operating Procedures C-2 to C-4 would be effective in protecting streams and prevent additional freeze down of deep-water pools harboring overwintering fish and invertebrates. Required Operating Procedure E-1 would be effective in protecting subsistence use and access to traditional subsistence fishing areas and minimize the effects of oil and gas development on fish resources. Required Operating Procedures and Lease Stipulations E-2, E-3, E-6, and E-8 would be effective in maintaining free passage of marine and anadromous fish and to protect fish habitat as well as subsistence use and access to traditional subsistence fishing. Required Operating Procedure E-7 would be effective in minimizing disruption of caribou movement and subsistence use by elevating pipelines to a minimum of 7 feet as opposed to the 5-foot minimum in the 1998 Northeast IAP/EIS ROD. Required Operating Procedure E-9 would be effective in minimizing human caused increases in populations of species that prey on ground nesting birds. Required Operating Procedure E-10 would be effective in preventing migrating waterfowl from striking oil and gas related facilities during low-light conditions. Required Operating Procedure E-11 would be effective in minimizing the take of species listed under the Endangered Species Act (e.g., spectacled and/or Steller's eiders and yellow-billed loons) and minimizing disturbance to other species caused by interaction with oil and gas facilities.

Required Operating Procedure F-1 would be effective in minimizing the effects of low-flying aircraft on wildlife. Lease Stipulations K-1 and K-2 would be effective in minimizing the disruption of natural flow patterns; changes to water quality; changes to floodplain and riparian areas; and loss of fish spawning, rearing, or overwintering habitat through setbacks along rivers and around lakes. Lease Stipulations K-3, K-5, K-6, and K-7 would be effective in protecting fish and wildlife habitat and minimizing disturbance of caribou and alteration of migration patterns in the Teshekpuk Lake region and in coastal areas.

Effectiveness on Subsistence Harvest Patterns

In general, the ROPs and lease stipulations seek to protect specific resources by establishing spatial buffer zones around facilities and infrastructure, scheduling disruptive activities for periods with the least potential for conflicts with other users, making efforts to include community residents in project planning, monitoring effects on subsistence resources, and minimizing interference of oil and gas exploration and development activities and structures with subsistence resources and users. The effectiveness of these measures depends heavily on their ongoing implementation, enforcement, and local participation. Required Operating Procedure A-4 would be effective in minimizing the impact of contaminants (spills) on fish, wildlife, and the environment, and to protect subsistence activities and resources. Required Operating Procedure E-1 would be effective in protecting subsistence use and access to traditional subsistence hunting and fishing areas. Lease Stipulation E-3 would be effective in maintaining free passage of marine and anadromous fish and protect subsistence use and access

to traditional subsistence hunting and fishing. Required Operating Procedure E-7 would be effective in minimizing the disruption of caribou movement and subsistence use by requiring that pipelines and roads be designed to allow the free movement of caribou and the safe and unimpeded passage of subsistence hunters. Ground pipelines would be elevated a minimum of 7 feet to facilitate wildlife passage and subsistence passage and access, ramps would be placed, after consultation with appropriate Federal, state, and NSB regulatory and resource management agencies, in areas where facilities or terrain funnel caribou movement, and pipelines and roads would be separated by 500 feet where possible.

Required Operating Procedure F-1 would be effective in minimizing the effects of low-flying aircraft on wildlife, traditional subsistence activities, and local communities. This ROP is designed to minimize aircraft disturbance of caribou and bird populations and sensitive habitat areas, especially near known subsistence camps and cabins or during sensitive subsistence hunting periods (spring goose hunting and fall caribou and moose hunting). Required Operating procedures H-1 and H-2 are subsistence-specific mitigation procedures designed to provide opportunities for participation in planning and decision-making to prevent unreasonable conflicts between subsistence uses and oil and gas-related activities including seismic exploration. Required Operating Procedure H-2 would define potentially affected cabins or campsites and would provide for additional consultation requirements for geophysical exploration beyond those required in ROP H-1. Required Operating Procedure I-1 would require the lessee to provide a cultural orientation program for all oil and gas workers to minimize cultural and resource conflicts with local inhabitants. Of special concern is aircraft use near traditional subsistence cabins and campsites during spring goose and fall caribou and moose hunting.

Lease Stipulations K-1 and K-2 would be effective in minimizing impacts to subsistence cabins and campsites and disruptions to subsistence activities by prohibiting permanent oil and gas facilities (e.g., gravel pads, roads and airstrips, and pipelines) through setbacks along/around the Colville, Ikpikpuk, Miguakiak, Kikiakrorak and Kogosukruk rivers, Fish and Judy creeks, and Deep Water Lakes areas. Lease Stipulation K-3 would be effective in protecting subsistence resources and access to the Teshekpuk Lake area by ensuring that there would not be unreasonable conflicts with traditional subsistence uses and access or impacts to seasonally concentrated fish and wildlife resources. Lease Stipulation K-6 would be effective in minimizing impacts to subsistence activities in coastal areas through a setback of ¾ of a mile from the coastline, to the extent practicable, as well as the use of previously occupied sites (e.g., Camp Lonely, various Husky/USGS drill sites and DEW-Line sites).

Some stipulations, such as Stipulations K-4 and K-5, serve to protect resources such as caribou and waterfowl by limiting the types of activities that can take place, and defining restrictions on activities, during certain times of the year. While these protections serve to ensure healthy populations, they also lead to periods of concentrated activity, usually in the fall months of August-October. This resulting period of concentrated activity is also the preferred time to harvest caribou, namely, during the cool days of fall before the rut, when the caribou have the greatest fat supply. This leads to increased disruption to harvesters by aircraft, resulting in the low-level impact of frustration of the user, to the high-level impact of an overall reduction in harvest.

4.4.12.4 Conclusion

Most impacts associated with oil and gas activities under Alternative B would be localized and would not substantially affect subsistence species, as long as the activities occurred outside of

key habitat areas or migratory zones when animals were present. Under Alternative B, 213,000 acres north of Teshekpuk Lake would remain unavailable for oil and gas leasing. However, areas that would be unavailable for year-round occupation and development under Alternative A would become available under this alternative, and could be affected by oil and gas exploration activities, resulting in a greater likelihood of impacts to subsistence use. Should development proceed under Alternative B, the duration, severity, and extent of the effects of oil and gas development activities on subsistence species could be greater than under Alternative A, as there would be a larger area open for year-round occupation and development, which include ecologically sensitive areas. The amount of habitat loss and degradation would be greater under Alternative B than under Alternative A. Permanent facilities associated with development, if located in key migration corridors or other areas essential to the viability of the population, could result in reduced harvests, and a reliance on other sources of food. The ROPs and lease stipulations discussed above would be effective in protecting subsistence species and helping to resolve conflicts between the oil and gas industry and local residents. Even in the best case scenario of species protection, however, subsistence users would still be constrained by the presence of oil and gas facilities from harvesting subsistence resources, would question the health of those resources, and would tend to harvest resources at least 5 miles from areas of development, increasing the distance hunters must travel, and reducing the total harvest area available, with each new wave of development. As expressed in public scoping testimony, local residents are fearful for the future of subsistence hunting on the North Slope, their ability to carry on with traditional customs and ways, and their ability to be able to pass along these traditions to their children.

4.4.13 Sociocultural Systems

4.4.13.1 Activities Not Associated With Oil and Gas Exploration and Development

Under Alternative B, the effects of non-oil and gas activities on sociocultural patterns would be greater than under Alternative A. There would be a greater amount of scientific research and data collection undertaken prior to lease sales and as part of Federal land management responsibilities. These research efforts and associated aircraft use could cause temporary and localized diversion or deflection of subsistence species for as long as the studies were under way. It is not expected that the amount of recreational and solid and hazardous waste removal and remediation would be greater under Alternative B, but more overland moves could be required to support scientific and other activities in the new areas available for leasing. Several families from Atqasuk, Barrow, and Nuiqsut use cabins, camps, caches, and other sites along the coast and inland to Teshekpuk Lake for subsistence activities. Use of this area helps maintain family connections and a feeling of relatedness and stability, which could be reduced by increased activity in the areas formerly closed to leasing. In general, effects from non-oil and gas activities under Alternative B would be temporary and localized, and would be unlikely to affect overall sociocultural patterns.

4.4.13.2 Oil and Gas Exploration and Development Activities

Oil and gas exploration, development, and production in the areas formerly unavailable for leasing north of Teshekpuk Lake and in areas outside the setbacks established in the lease stipulations and ROPs would require a seasonal network of ice roads, permanent gravel roads, runways, and pads, and a year-round corridor for pipelines and powerlines to each pad and production facility.

Effects of Disturbances

The kinds of impacts on sociocultural patterns from disturbances caused by oil and gas activities under Alternative B would be the similar to Alternative A, but would be greater in intensity, area, and duration. Increases in the amount of area available for leasing and exploration would have a corresponding increase in the effects to subsistence harvests as compared to those for Alternative A. The development proposed for the planning area would require increased staging and overland travel during the winter and in summer would require increased use of aircraft for supplies, equipment, and crew changes, as compared to Alternative A. In all seasons, noise, lights, personnel, and traffic near oil and gas-related infrastructure could temporarily deflect or divert caribou in areas where activities are occurring; however, gravel pads could attract caribou during some seasons as insect-relief habitat. These effects could change the distribution, timing, and location of the caribou harvest, which could require increased effort and expenditure on the part of subsistence hunters, resulting in sociocultural consequences such as increased stress and a decreased sense of well-being. These problems are discussed in more detail in **section 4.4.19**. Oil and gas development could divert subsistence users from facilities at distances from 5 to more than 25 miles. Given the high gasoline costs on the North Slope, this would add additional cost to subsistence harvests. Increased fuel costs and wear and tear on equipment would increase the need for wage labor to support subsistence pursuits and reduce the time available to pursue subsistence activities, which would result in sociocultural consequences, such as increased stress and a decreased sense of well-being. Increases in the speed, range, and reliability of outboards and snowmobiles have facilitated the mixed subsistence and wage economy, but are unable to compensate for impacts to subsistence harvest activities from continued development and production activities in important subsistence harvest areas.

As discussed under Alternative A, long-term change to sociocultural patterns would result from a weakening of traditional stabilizing institutions through prolonged stress and disruptive effects that could be exacerbated by activities occurring under this alternative. These changes are already occurring to some degree on the North Slope because of onshore oil and gas development, more dependence on a wage economy, higher levels of education, improved technology, improved housing and community facilities, improved infrastructures, increased presence of non-Natives, increased travel outside of the North Slope, and increasing presence of television and the Internet. Data from other circumpolar Inuit populations suggest that continued modernization is associated with a trend toward displacement of sociocultural systems, including: a trend toward less time being spent conducting subsistence harvest activities; less subsistence consumption among younger generations; a greater focus on a cash-based economy, as opposed to the egalitarian sharing network; an increased importance on the nuclear family, as opposed to the more-traditional extended family structure (Curtis et al. 2005; Nobmann et al. 2005; Condon et al. 1995). North Slope Borough institutions, such as the school district that promotes the teaching of Iñupiat language and culture, the Arctic Eskimo Whaling Commission that negotiates with industry to protect Iñupiat subsistence whaling interests, the NSB Department of Wildlife Management, and other regional and village Native corporations and organizations, have been working vigorously and quite successfully at preventing the weakening of traditional Iñupiat cultural institutions and practices. Increased social interactions between oil-industry workers and Nuiqsut residents could be long term, but there is not expected to be a tendency toward displacement of Iñupiat social institutions. However, population changes in ethnicity, such as the influx of a large non-native population, could disrupt or displace existing sociocultural systems and cultural institutions. Small-scale changes in population and employment are unlikely to disrupt sociocultural systems or displace existing institutions (USDOI BLM and MMS 1998, 2003).

Effects of Abandonment and Rehabilitation

Abandonment and rehabilitation activities would likely generate jobs for local residents for several years above the level that would exist during operations. However, after the production pads were shut down and termination activities were completed, jobs associated with them would cease. If local residents were to become substantially integrated into satellite operations and the community was to become substantially dependent on revenues associated with their operation, and if other oil fields were not active in the area to provide jobs and contribute economically to the local economy and government revenues, the community would face a time of significant economic depression; other potential avenues for maintaining income at the standards established in the oil development era have not been identified. Subsistence resources would be subject to fewer impacts, which would potentially improve subsistence harvesting opportunities.

Effects of Oil Spills

The effects of oil spills would be the similar as discussed in Alternative A; however, under Alternative B there would be a greater likelihood that a spill event could occur with the potential to damage important habitats and subsistence use areas. Effects would vary in severity depending upon the timing and location of the spill event, but fish, waterfowl, and marine and terrestrial mammals could all be affected. An oil spill could result in contamination of subsistence resources and would be a threat to the health and lifeways of the affected communities. If a large oil spill occurred in a traditional use area, then subsistence users would have to travel further to harvest uncontaminated resources, which would result in high effects to sociocultural patterns as long as the residents believed that the subsistence resources were contaminated.

Activities associated with cleanup of an oil spill could have an effect on sociocultural systems. In the event that a large spill contacted and extensively oiled habitats, the presence of hundreds of humans, boats, and aircraft would increase the displacement of subsistence species and alter or reduce access to subsistence species by subsistence hunters. Because it is expected that oil spills from activities would be small, chronic events and would normally be contained on the drill pad, effects from the spills themselves and potential disruptions from clean-up activities would be unlikely to cause excessive disturbance to sociocultural systems or the surrounding environment.

Commercial Gas Development

Effects on sociocultural systems under Alternative B and all other alternatives would be due to effects on subsistence harvest patterns, changes in employment and population, and effects on public health. In the event of natural gas development and production in the planning area, there could be an increase in employment and population in some North Slope communities and subsistence use patterns and public health may be affected as described in **sections 4.4.12 and 4.4.19**, respectively. The amount of employment and population change would probably differ among the alternatives in rough proportion to the amount of oil production and infrastructure development that would occur under each alternative.

4.4.13.3 Effectiveness of Stipulations and Required Operating Procedures

The performance-based lease stipulations and ROPs proposed under Alternative B would provide equivalent or greater setbacks from rivers and lakes than under Alternative A, but

would allow drilling within lakes outside those setbacks. While Federal trust responsibilities would remain unchanged under all alternatives, during scoping, residents stated that the proposed lease stipulations and ROPs under Alternative B would be more permissive to lessees, and would diminish what local residents consider to be the BLM's trust responsibilities in supporting and maintaining subsistence uses in the planning area. In their view, BLM would be shifting the responsibilities for enforcing the lease stipulations and ROPs to other local, state and Federal agencies (Ahmaogak 2003, Napageak 2003).

The BLM perspective on the effectiveness of mitigation measures differs significantly. BLM proposes the new approach to mitigation measures in order to achieve equivalent protection as would occur under Alternative A, while providing greater flexibility. The prescriptive approach adopted in 1998 gained legitimacy and credibility through the extended consultation leading to the final decision, while the new approach proposed for Alternative B is not well known or understood, and some local residents doubt that the new approach would provide equivalent protection. The flexibility of the new approach places greater reliance on close, on-going monitoring to insure that modified procedures do in fact achieve equivalent protections.

Required Operating Procedure I-1 would require the lessee to provide a cultural orientation program for all oil and gas workers involved in planning area activities in order to effectively minimize cultural and resource conflicts with local inhabitants. This orientation program, as it relates to subsistence pursuits and cultural concerns, would: 1) provide sufficient detail to notify personnel of applicable lease stipulations and ROPs, as well as inform them about specific types of environmental, social, traditional, and cultural concerns that relate to the region; (2) address the importance of not disturbing archaeological and biological resources and habitats, and provide guidance on how to avoid disturbance; 3) be designed to increase sensitivity and understanding of personnel to community values, customs, and lifestyles in areas where personnel would be operating; 4) include information about avoidance of conflicts with subsistence, commercial fishing activities, and pertinent mitigation; and 5) include information for aircraft personnel concerning subsistence activities and areas and seasons that are particularly sensitive to disturbance by low flying aircraft (e.g., aircraft use near traditional subsistence cabins and campsites, flights during spring goose hunting and fall moose hunting seasons, and flights near North Slope communities).

4.4.13.4 Conclusion

Despite the fact that 213,000 acres would be unavailable for leasing under this alternative, new lease sales in the areas formerly unavailable to leasing north and west of Teshekpuk Lake could cause societal stress in Barrow, Nuiqsut, and Atqasuk. Construction and operation of oil facilities could discourage families from using and maintaining traditional camps, cabins, and caches in the affected areas, which could affect social organization and cultural values in these communities. Development in these areas would increase North Slope residents' concerns about encroachment and potential risks to subsistence resources in terms of access, availability, and contamination of caribou, fish, and waterfowl. Visits to traditional camps and cabins, and hunting and travel within the planning area, are vehicles for transmitting traditional and family history and knowledge to younger generations, and the discontinuation of such visits would decrease social cohesion in these communities. In addition, as harvests decrease, resources would no longer be available in amounts suitable for sharing, resulting in changes to Iñupiat social organization and cultural values.

4.4.14 Environmental Justice

4.4.14.1 Activities Not Associated With Oil and Gas Exploration and Development

The non-oil and gas activities likely to occur in the planning area would primarily be transitory in nature, of short duration, and highly localized. They could temporarily divert, deflect, or disturb subsistence species from their normal patterns. Non-oil and gas activities could alter the availability of subsistence species in traditional harvest areas, which could affect harvest patterns by requiring hunters to travel further in pursuit of resources. Increased travel distances would result in greater expenditures for fuel and equipment, and increased wear and tear on snowmobiles, outboards, and four-wheel vehicles, and could result in higher risk of accidents. Consequently, there could be an effect on the subsistence hunting activities of the local minority population as a result of non-oil and gas activities. As outlined in **section 4.4.19**, this could result in isolated problems of social pathology. Under Alternative B, these effects could be slightly greater than under Alternative A, but would still be minor, temporary, short term, and generally highly localized.

4.4.14.2 Oil and Gas Exploration and Development Activities

Effects of Disturbance

Under Alternative B, disturbances caused by oil and gas activities would be the similar as those discussed under Alternative A, but their effects on subsistence would be increased in magnitude, extent, and duration. Areas that would be unavailable for year-round occupation and development under Alternative A would be available for lease and year-round surface occupation under Alternative B, and could be affected by oil and gas development. Development activity could last at least 30 years, following 8 to 12 years of permitting, planning, and oil deposit testing and delineation. This time frame would likely represent the duration of effects for species unable to habituate to the oil and gas development activities. Public health effects relating to sociocultural and dietary change, as well as exposure to contaminants, could persist for considerably longer.

Alternative B could have long-term effects on several terrestrial mammal species. In particular, effects on caribou herds would likely be greater than under Alternative A (**section 4.3.9, *Mammals***). It is expected that effects on waterfowl harvested for subsistence would be more frequent and more widespread than under Alternative A, given the greater area available for petroleum leasing. Little or no effect on marine mammals would be expected from onshore activities under Alternative B, but noise and disturbance associated with offshore barge and vessel traffic could impact bowhead whale migration patterns. There are concerns that, depending on the particular activity and, especially, the location of the activity, actions occurring under Alternative B, as under Alternative A, could cause local effects on fish populations. All of these effects would be experienced primarily by the subsistence dependent minority Iñupiat population.

Under Alternative B, the possibility of public health impacts would be substantially increased compared with Alternative A, but overall less than under Alternative C. These impacts would occur primarily through restriction in subsistence; influx of large numbers of outside workers; new access routes to the community; sociocultural and economic change; altered employment; and contaminants. Diabetes, hypertension, and related metabolic disorders would be expected to increase as subsistence is curtailed or as sociocultural changes lead to alterations in dietary patterns. Given that Alternative B involves substantially more development in and near particularly sensitive habitat and hunting and fishing areas than Alternative A, the risk of dietary change and the resultant increases in metabolic disorders would appear to be significantly greater. Cancer, lung disease, endocrine disruption, and neurodevelopmental delay are related to contaminants common to oil and gas development. Although at present no evidence exists to conclusively link rates of any of these problems to local oil development, because of both the increased total emissions projected under this Alternative, and the location of operations within an important subsistence area, the risks of these problems may be increased under Alternative B. Social pathology could result from the economic changes anticipated; from increasing access to drugs and alcohol; and from stress and maladaptive coping given the impacts to wider regions of important traditional use areas.

Effects of Abandonment and Rehabilitation

Activities associated with dismantling and removing of production pads and facilities could disproportionately impact Nuiqsut residents through disturbance, displacement, and mortality of subsistence resources, through subsistence users' avoidance of areas undergoing dismantlement and removal, and through potential impacts to water and air quality, and noise. Once abandonment and rehabilitation was completed, Nuiqsut residents would be disproportionately impacted by the reduction in local and Native corporation revenues and by fewer local jobs and business opportunities. Since economic depression is associated with increased social pathology, this could result in increases in domestic violence, injury, drug and alcohol problems, and suicide. Local residents could benefit from a reduction in impacts on subsistence resources, compared to during construction and operation.

Effects of Oil Spills

As discussed elsewhere, the magnitude of effects of a crude oil spill on subsistence resources would depend on the context of the spill, the volume and area covered by spilled product, and the amount of time the product was released before clean-up efforts commenced. Tundra oil spills could affect small numbers of terrestrial mammals and waterfowl unable to avoid the spill area, but would be unlikely to have population level effects. Oil spills directly into a water body, particularly in difficult to contain conditions such as breakup or broken ice, could spread widely

and have effects on fish and waterfowl. In the nearshore environment, a large to very large spill, particularly during broken ice or storm conditions, could affect marine mammals including seals, and beluga and bowhead whales. Oil spills can also be associated with toxicological health effects in human populations, as outlined in **section 4.4.19**. Furthermore, if a large spill resulted in a substantial decrease in consumption of subsistence foods, food insecurity and hunger as well as diabetes and related metabolic disorders could increase.

The Iñupiat people consider contamination from oil spills in nearshore waters to be a catastrophic possibility that would threaten their very existence, primarily because of the potential effects of spills on bowhead whales, which are a very important part of their culture in addition to being a favored food source (Brower 1976, Itta 2001). Potential effects on subsistence harvest patterns would be greater under Alternative B because oil and gas activity would potentially occur over a larger area in the planning area than under Alternative A, and there would thus be a greater potential for oil spills. A major oil spill on the North Slope would result in effects that would impact Iñupiat subsistence users more than any other human group.

Commercial Gas Development

Environmental Justice impacts of gas development for Alternative B would be largely attributable to impacts to subsistence, sociocultural changes, and public health impacts and are described, respectively, in **sections 4.4.12, 4.4.13, and 4.4.19**. While impacts from an oil spill would not be a factor, it is possible that well blowouts or the fear of blowouts would increase subsistence users' avoidance of infrastructure. The proportional impacts among the alternatives would mirror that attributed to oil development, and therefore Alternative B would likely create more impacts than Alternative A.

4.4.14.3 Effectiveness of Stipulations and Required Operating Procedures

The lease stipulations and ROPs for Alternative B would protect subsistence resources to the same extent as the lease stipulations under Alternative A. Required Operating Procedures H-1 and H-2 would be highly effective in reducing conflicts between subsistence uses and oil and gas-related activities.

4.4.14.4 Conclusion

Several lease sales have already taken place in the planning area. Exploration programs, consisting of seismic testing and drilling using ice pads, are ongoing. Residents of Barrow, Nuiqsut, and Atqasuk have noted some effects from these activities on subsistence (SRBA 2003a,b). One effect included the redistribution of caribou, wolves, and wolverines in response to seismic activity and cat trains operating in the NPR-A (SRBA 2003a, b). These effects would continue under Alternative B, and would be somewhat greater than under Alternative A. Most effects of disturbance would still be short term, but the extent and magnitude would likely increase. Effects from oil spills would depend greatly on the size, location, and season of the spill. Small spills on gravel pads would have little or no environmental justice effects. A major spill into a watercourse, on the other hand, could have long term serious effects on Iñupiat subsistence activities. While any major spill would have serious consequences, the worst, from an environmental justice standpoint, would be one that occurred in a key harvest area or near a community, particularly Nuiqsut or areas used by Barrow residents in the northwest portion of the planning area.

The anticipated activities under Alternative B could also have substantial health effects, as outlined above and discussed in detail in **section 4.4.19**. Because the population within and near the planning area is primarily comprised of Iñupiat, any health effects that occur would disproportionately affect this minority population.

4.4.15 Coastal Zone Management

4.4.15.1 Activities Not Associated With Oil and Gas Exploration and Development

Under Alternative B, non-oil and gas activities would be subject to all applicable lease stipulations and ROPs, as well as any other Federal, state, or NSB regulations pertaining to the activities in question. These activities would be subject to permitting, and would include the activities noted in **section 4.2.1.1, *Activities Not Associated with Oil and Gas Exploration and Development***, and evaluated for Alternative A in **section 4.3.15.1, *Coastal Zone Management***. As non-oil and gas activities are normal occurrences under existing BLM management practices, they would, in most cases, be of limited duration and magnitude, and effects on neighboring uses, primarily subsistence resources and harvest patterns of nearby communities, would be limited to the immediate area of the activity. Activities would be consistent with ACMP standards.

4.4.15.2 Oil and Gas Exploration and Development Activities

As described in **section 4.3.15, *Coastal Zone Management*** of this document, Section 307(c)(3)(B) of the CZMA requires applicants to certify that each of their activities that affects any land use or water use in the coastal zone complies with, and would be implemented consistent with, the state's coastal management program. In the following discussion, ACMP standards for uses and activities are used to evaluate activities and effects that would occur under Alternative B. Policies of the NSB CMP are assessed in conjunction with the most closely associated statewide standard.

This analysis is not a consistency determination pursuant to the Coastal Zone Management Act of 1972, as amended, nor should it be used as a local planning document.

Effects of Exploration and Development Related to the Alaska Coastal Management Program

Coastal Development (11 AAC 112.200)

Water dependency is a prime criterion for development along the shoreline. The intent of this policy is to ensure that onshore developments and activities that could be placed inland would not displace activities that depend on shoreline locations, which include marine shores, lakeshores, and river waterfronts. Under Alternative B, almost the entire Beaufort Sea coast within the planning area would be open to leasing. Lease Stipulation K-6 would be highly effective in discouraging permanent oil and gas facilities within ¾ mile of the coast, and other ROPs and lease stipulations would address sensitive issues areas along parts of the coast and near deep-water lakes and major creeks and rivers.

Other lease stipulations and ROPs in place under Alternative B would further reduce the potential for conflicts with this policy around lakes and rivers. Specifically, ROPs and lease

stipulations related to waste-prevention, handling, and disposal and spills; ice roads and water use; facility design and construction; abandonment; protections for subsistence and traditional use sites; and other activities restrictions would be effective in reducing conflicts, making Alternative B consistent with the statewide standard (see Table 2-2 in Chapter 2).

Natural Hazard Areas (11 AAC 112.210)

This statewide standard permits coastal districts and state agencies to identify and designate areas in which natural hazards are known to exist that may present a threat to life or property. Development in these areas would be prohibited until siting, design, and construction measures for minimizing property damage and protecting against the loss of life were provided.

Flooding, earthquakes, active faults, tsunamis, landslides, volcanoes, storm surges, ice formations, snow avalanches, erosion, permafrost, and beach processes in the planning area should be considered. Onshore development would be sited in areas of permafrost. Development in these areas would be required to maintain the natural permafrost insulation quality of existing soils and vegetation (NSB CMP 2.4.6[c] and NSBMC 19.70.050.L.3). Alternative B would be required to comply with the statewide standard.

Coastal Access (11 AAC 112.220)

Districts and state agencies shall ensure that projects maintain and, where appropriate, increase public access to, from, and along coastal water. It is expected that Alternative B would be consistent with this standard, although the larger leasing area along the Beaufort Coast could lead to some conflicts with access opportunities, as compared to Alternative A.

Energy Facilities (11 AAC 112.230)

The ACMP requires that decisions on the siting and approval of energy-related facilities be based, to the extent practicable, on 16 criteria within the energy facilities standard. Lease stipulations and ROPs (see Table 2-2 in Chapter 2) in place under Alternative B would be effective in reducing conflicts, making the alternative consistent with the statewide standard.

Other criteria within this standard require that facilities be consolidated and sited in areas of least biological productivity, diversity, and vulnerability and where effluents and spills can be controlled or contained (11 AAC 112.230 (a) [3] and [14]). Under Alternative B, ROPs and lease stipulations would be effective in protecting biologically sensitive areas, although leasing would be permitted in coastal areas that would be off limits under Alternative A. The NSB CMP also requires that transportation facilities and utilities be consolidated to the maximum extent possible (NSB CMP 2.4.5.2[f] and NSBMC 19.70.050. K.6).

Construction associated with energy-related facilities under Alternative B would also be required to comply with siting standards that apply to all types of development, which are discussed below under Habitats; Air, Land, and Water Quality; and Historic, Prehistoric, and Archeological Resources.

Utility Routes and Facilities (11 AAC 112.240) and Transportation Routes and Facilities (11 AAC 112.280)

These statewide standards require that routes for transportation and utilities be compatible with district programs and sited inland from shorelines and beaches. Utility routes and

facilities along the coast must avoid, minimize, or mitigate alterations in drainage patterns, disruption in wildlife transit, and blockage of existing or traditional access.

The NSB CMP contains several additional policies related to transportation and utilities that would be relevant to this analysis. All but one are best-effort policies, and are subject to some flexibility. Transportation development, including pipelines, which significantly obstructs wildlife migration, is subject to three conditions (NSB CMP 2.4.5.1[g] and NSBMC 19.70.050.J.3.f). Interference with caribou movements would be temporary and brief under Alternative B; caribou migrations and overall distribution should not be affected. Lease stipulations and ROPs in place under Alternative B would be effective in reducing conflicts, making the alternative consistent with the statewide standard.

Transportation facilities would be consolidated to the maximum extent practicable. Therefore, there should be no conflict with either NSB CMP 2.4.5.1(i) (NSBMC 19.70.050.J.3.h), which discourages duplicative transportation corridors from resource-extraction sites, or NSB CMP 2.4.5.2(f) (NSBMC 19.70.050.K.6), which requires consolidation of transportation facilities and utilities. Lease stipulations and ROPs required under Alternative B would be highly effective in reducing conflicts, making this alternative consistent with the statewide standard.

The NSB CMP 2.4.6(b) (NSBMC 19.70.050.L.2), under the category of Minimization of Negative Impacts, requires that alterations to water features associated with transportation and utilities be minimized, and that periods critical for fish migration be avoided. Lease Stipulation K-6, in particular, would be effective in ensuring compliance with this standard.

Sand and Gravel Extraction (11 AAC 112.260)

The ACMP statewide standards indicate sand and gravel may be extracted from coastal waters, intertidal areas, barrier islands, and spits if no practicable noncoastal alternative is available to meet the public need. Substantial alteration of shoreline dynamics is prohibited (NSB CMP 2.4.5.1[j] and NSBMC 19.70.050.J.10). Constraints may be placed on extraction activities to lessen environmental degradation of coastal lands and waters (NSB CMP 2.4.5.2[a] and [d] and NSBMC 19.70.050.K.1 and 4). Substantially more gravel could be required under Alternative B than under Alternative A, but ROPs and lease stipulations (see Table 2-2 in Chapter 2) would place restrictions on gravel mining locations and thus effectively reduce conflicts to ensure compliance with this standard and the NSB policies.

Subsistence (11 AAC 112.270)

The statewide standard for subsistence indicates a project within a designated subsistence use area must avoid or minimize impacts to subsistence uses of coastal resources. Subsistence uses of coastal resources and maintenance of the subsistence way of life are primary concerns of the residents of the NSB. Under Alternative B, most of the Beaufort Sea coast would be open to leasing. As a consequence, access to subsistence resources could be more limited than under Alternative A. Disturbances and oil spills associated with oil and gas activities would have short-term and localized impacts on the TLH caribou and other terrestrial mammals, fish, birds, and bowhead whales and other marine mammals. The impacts would result in more difficult and somewhat reduced success at subsistence harvests for Barrow, Atqasuk, and Nuiqsut hunters. Subsistence-hunter concerns about access to resources, resource disturbance, and resource contamination would be greater than for Alternative A. Lease stipulations would offer protection to subsistence resources and activities. Surface, air, and foot traffic near the oil fields would be expected to increase more than under Alternative A and would potentially displace

larger numbers of caribou, moose, muskox, grizzly bears, wolves, and wolverines. Roads and pipelines would be constructed to provide for unimpeded wildlife crossings. Based on the analysis of disturbance effects on caribou, potential conflict with the subsistence policies would be greater under Alternative B than under Alternative A, although Alternative B would still comply with the statewide standard.

Policy 2.4.3(d) (NSBMC 19.70.050.D) requires that development not preclude reasonable access to a subsistence resource. Onshore pipelines and construction activities could cause disruptions to subsistence caribou harvests from access and movement conflicts, but effects are expected to be short term. Where access is reduced or restricted, development can occur only if no feasible or prudent alternative is available, and is then subject to the conditions of best-effort policies. Conflict with these standards and policies would be somewhat greater under Alternative B than under Alternative A.

Several important NSB CMP policies relate to effects on subsistence resources. The NSB CMP policy 2.4.3(a) (NSBMC 19.70.050.A) relates to extensive impacts to a subsistence resource that are likely and cannot be avoided or mitigated. In such an instance, development must not deplete subsistence resources below the subsistence needs of local residents of the NSB. Policy 2.4.5.1(a) (NSBMC 19.70.050.J.3.a) addresses development that would likely result in substantially decreased productivity of subsistence resources or their ecosystems. Temporary reductions in subsistence resources and changes in subsistence resource-distribution patterns could occur as a result of disturbance from seismic surveys, aircraft and vessel traffic, drilling activities, and construction activities.

The development scenario under Alternative B predicts that there would be an onshore pipeline for oil delivery to the TAPS and that a pipeline spill could potentially contaminate the Colville River. A spill entering the Colville River potentially could affect the subsistence harvest by reducing fish populations, disrupting subsistence-fishing activity, and curtailing the subsistence hunt by tainting resources or causing subsistence users to perceive them as tainted. The effects of estimated oil spills of different sizes and their impacts on subsistence uses are discussed in **section 4.3.12**.

Conflict with policies to protect subsistence resources would be possible during the exploration, development, and production phases. Under Alternative B, ROPs and lease stipulations (see Table 2-2 in Chapter 2) designed to protect subsistence resources, and to establish procedures and advisory bodies to address subsistence concerns, would be effective in minimizing policy conflicts. Therefore, Alternative B would be consistent with the statewide standard.

Habitats (11 AAC 112.300)

The statewide standard for habitats contains management measures for nine habitat areas: offshore areas; estuaries; wetlands; tideflats; rocky islands and seacliffs; barrier islands and lagoons; exposed high-energy coasts; rivers, streams, and lakes (including associated floodplains and riparian management areas); and important upland habitat. The NSB CMP contains a district policy that reiterates the applicability of the statewide standard (NSB CMP 2.4.5.2[g] and NSBMC 19.70.050.K.7), plus several others that augment the overall policy or can be related to activities within a specific habitat. Under Alternative B, fewer sensitive habitat areas would be excluded from leasing than under Alternative A. However, applicable ROPs and lease stipulations would provide effective protection for fish, birds, and terrestrial mammals, and their habitats. Therefore, conflicts with the ACMP standards would be minimized to the degree possible, making activities under Alternative B consistent with the statewide standard.

The ACMP statewide standard for habitats in the coastal zone requires that habitats be managed to avoid, minimize, or mitigate significant adverse impacts to habitat resources. This policy is supported by an NSB CMP enforceable policy requiring that development be located, designed, and maintained in a manner that prevents or minimizes impacts on fish and wildlife and their habitat, including water circulation and drainage patterns and coastal processes (NSB CMP 2.4.5.2[b] and NSBMC 19.70.050.K.2). In addition, vehicles, vessels, and aircraft that are likely to cause disturbance must avoid areas where species that are sensitive to noise or movement are concentrated, at times when such species are concentrated (NSB CMP 2.4.4[a] and NSBMC 19.70.050.I.1). Some disturbances associated with exploration and development would be mitigated by ROPs and lease stipulations placed on permits. Alternative B ROPs and lease stipulations would be effective in reducing potential conflicts, and the activities would be consistent with the statewide standard.

Oil and gas development activities could affect several of the habitats identified in the statewide standard, including lagoons, wetlands, rivers, lakes, and streams. Therefore, onshore-development activities would need to be designed and constructed to avoid, minimize, or mitigate significant adverse effects.

It is expected that caribou of the CAH and TLH would be disturbed and their movements delayed along the pipeline during periods of aircraft overflights, but that disturbances would not affect migrations or overall distribution. It is expected that surface, air, and foot traffic near the oil fields would be greater under Alternative B than under Alternative A and could displace some large mammals, though not enough to substantially affect North Slope populations. The NSB CMP policy 2.4.6(e) (NSBMC 19.70.050.L.5) emphasizes that roads and pipelines must provide for unimpeded wildlife crossing and provides a set of guidelines and an intent statement specifically to implement the policy.

Rivers, lakes, and streams are managed to avoid, minimize, or mitigate significant adverse impacts to natural water flow; active floodplains; and natural vegetation within riparian management areas. Pipeline and road construction, including gravel extraction, could affect these waterways and would need to be conducted in a manner that would ensure the protection of riverine habitat and fish resources. Gravel extraction also is regulated under policies that are described in Section 11 AAC 112.260. The ROPs and lease stipulations (see Table 2-2 in Chapter 2) in place under Alternative B would be effective in reducing conflicts, and would be consistent with the statewide standard.

Air, Land, and Water Quality (11 AAC 112.310)

The air, land, and water quality standard of the ACMP incorporates by reference all the statutes pertaining to, and regulations and procedures of, the ADEC. The NSB reiterates this standard in its district policies and emphasizes the need to comply with specific water and air quality regulations in several additional policies. North Slope Borough policies (NSB CMP 2.4.4[k] and NSBMC 19.70.050.I.11) address water quality issues, and development must comply with the conditions of the best-effort policies (NSB CMP 2.4.5.1[e] and NSBMC 19.70.050.J.3.d). Under Alternative B, there could be some short-term conflict with these policies due to potential oil spills, which would likely to be more frequent under Alternative B than under Alternative A. However, the ROPs and lease stipulations (see Table 2-2 in Chapter 2) in place under Alternative B would be effective in reducing conflicts, and the alternative would be consistent with the statewide standards.

Some discharges and emissions would occur during exploration and development, and the NSB CMP policy 2.4.4(c) (NSBMC 19.70.050.I.3) requires that these emissions comply with all state and Federal regulations.

Discharges of drilling muds, cuttings, and fluids are regulated closely. Formation water produced from the wells along with the oil is regulated by the USEPA. The Alaska Oil and Gas Conservation Commission (AOGCC) has primacy for this program. Some wastes are disposed through the annulus of producing wells, an activity that is exempt from the Underground Injection Control program. However, the AOGCC also regulates this practice for the State of Alaska. Surface disposal of drilling wastes would require a solid waste permit from ADEC.

Because discharges of drilling muds, cuttings, and drilling fluids are closely regulated, no conflict is anticipated with the statewide standard or NSB CMP policy 2.4.4(d) (NSBMC 19.70.050.I.4), which requires that industrial and commercial development be served by solid waste disposal facilities that meet state and Federal regulations. There would be no inherent conflict between the proposed activities of Alternative B and the ACMP water-quality provisions.

Air quality also must conform to Federal and state standards (11 AAC 112.310, NSB CMP 2.4.3[i] and 2.4.4[c], and NSBMC 19.70.050.H and I.3). The analysis of air quality effects under Alternative B in **section 4.4.1, *Air Quality***, indicates that conformance is anticipated, and no conflict between air quality and coastal policies should occur.

Historic, Prehistoric, and Archaeological Resources (11 AAC 112.320)

The ACMP statewide standard requires that coastal districts and appropriate state agencies identify areas of the coast that are important to the study, understanding, or illustration of national, state, or local history or prehistory, including natural processes.

The NSB developed additional policies to ensure protection of its heritage. The NSB CMP 2.4.3(e) (NSBMC 19.70.050.E) requires that development that is likely to disturb cultural or historic sites listed on the National Register of Historic Places; sites eligible for inclusion in the National Register; or sites identified as important to the study, understanding, or illustration of national, state, or local history or prehistory shall 1) be required to avoid the sites, or 2) be required to consult with appropriate local, state and Federal agencies and survey and excavate the site prior to disturbance. The NSB CMP 2.4.3(g) (NSBMC 19.70.050.G) also requires that development not disturb newly discovered historic or cultural sites prior to archaeological investigation. It is likely that new cultural and paleontological sites would be discovered under Alternative B. No conflicts with these policies would be expected; however, ROPs and lease stipulations would be highly effective by requiring an inventory of traditional use sites prior to conducting any activities. Therefore, Alternative B would be consistent with the statewide standard.

Traditional activities at cultural or historic sites also are protected under the NSB CMP 2.4.3(f) (NSBMC 19.70.050.F) and 2.4.5.2(h) (NSBMC 19.70.050.K.8). As noted in the discussion of policies related to subsistence, the latter is a best-effort policy that requires protection for transportation to subsistence use areas as well as cultural use sites. No conflict with these policies would be expected.

Effects of Abandonment and Rehabilitation

Land ownership would not be affected by abandonment and rehabilitation. Upon completion of abandonment and rehabilitation, land uses and management could return to as near the original condition as practicable.

Effects of Spills

Because of the interrelated nature of the ACMP and NSB CMP policies, the potential effects of spills were addressed with the effects of disturbances under each major policy area above. Discussion of oil spills, see **section 4.2.2.**

4.4.15.3 Effectiveness of Stipulations and Required Operating Procedures

Lease stipulations and ROPs (see Table 2-2 in Chapter 2) referred to under each of the Coastal Zone Policy standards discussed above should be sufficient for Alternative B to achieve compliance with ACMP and NSB CMP policies and standards. While it is expected that there could be land use and CZMP conflicts over the life of the alternative development scenario, any such conflicts should be short term and subject to resolution. Conflicts, should they occur, would most likely result from oil and gas development activities interrupting subsistence activities, but the scale of development and enforcement of applicable lease stipulations and ROPs would be effective in minimizing the conflicts and quickly returning the development to compliance with policies and standards.

4.4.15.4 Conclusion

It is expected that disturbance and oil spills associated with oil and gas activities would cause short-term and localized impacts to the TLH caribou and other terrestrial fish, birds, mammals, and bowhead whales and other marine mammals. In general, impacts to subsistence and other coastal zone resources from non-oil and gas activities, and from exploration and development activities, would be additive, except where these activities occurred in areas previously disturbed during exploration or development.

These impacts would likely be greater under Alternative B than under Alternative A, as would subsistence-hunter concerns about access to resources and resource contamination. The greater degree of impacts would result from opening additional area to leasing in caribou, waterfowl, and fishing areas, and because the expected level of development would be greater. Conflicts with ACMP and NSB CMP policies related to effects on subsistence resources resulting from periodic disturbance and oil spills would be possible, but no resource would become unavailable, undesirable for use, or experience overall population reductions. Implementation of ROPs and lease stipulations would effectively ensure that Alternative B would comply with ACMP standards and NSB CMP enforceable policies. Combined oversight by BLM, the ADNR, and the NSB, under the guidance of their respective standards, would deal with any potential conflict that could arise between Alternative B and the policies addressed in this section.

4.4.16 Recreational Resources

4.4.16.1 Activities Not Associated With Oil and Gas Exploration and Development

Under Alternative B, impacts to recreation resources from on-the-ground management activities such as archeological collection efforts, field camps, survey work, and overland moves would be very similar to recreation effects from Alternative A.

Temporary structures, vehicles, noise from generators, aircraft, human presence, and associated activity all would have some minimal short-term effects on the experience of solitude, naturalness, or primitive/unconfined recreation. As under Alternative A, the short-term impacts from Alternative B would be confined primarily to the activity site viewshed or noiseshed within approximately ½ mile in any direction of the activity (500 acres). All of the identified non-oil and gas activities would be transitory and short term; the likelihood of recreationists encountering them in any given location in the 4.6 million acre planning area would be small. If such activities were encountered, the recreation experience and opportunity for solitude on the North Slope would be diminished. Depending on the activity, there may be some increased likelihood of an encounter with recreationists because of the propensity to concentrate on major rivers and coastal areas.

A longer-lasting impact would be trails resulting from overland moves. These trails do not necessarily develop over the entire route of an overland move, but when they do they can be very detectable from the air for 2 to 5 years. They are typically more difficult to recognize from the ground. Vegetation can also be damaged along these trails from broken stems or the tops of tussocks being scraped off. Current operating procedures make this an infrequent problem but one that can occur in conjunction with these trails. Because overland moves would be relatively constant from year to year and generally follow the same route(s), several thousand miles of intermittent trail in some phase of recovery would likely be visible from the air during any one summer season. Though still relatively short term in nature, the linear nature of these trails would emphasize the presence of man, which would reduce the sense of naturalness and unconfined primitiveness to a small degree.

Although there are no formal designations of wilderness or wild and scenic rivers in the planning area, and none are anticipated at this time, none of the identified non-oil and gas activities would diminish requisite wilderness and wild and scenic river characteristics sufficiently to preclude such designations in the future.

4.4.16.2 Oil and Gas Exploration and Development Activities

Effects of Exploration

Under Alternative B, seismic work would occur throughout most of the planning area. This work would occur in winter using all-terrain ground vehicles supported by light aircraft. Mobile seismic camps would consist of a train of trailer sleds pulled by tractors. These moving camps and associated noise and activities would result in a short-term effect on the primitive setting of the planning area and a loss of solitude and naturalness. The effects would be confined primarily to the activity site viewshed or noiseshed, or within approximately ½ mile in any direction. As many as five seismic operations could take place in a season, temporarily affecting approximately 2,500 acres. The potential effect on recreation opportunities and experience would be minimized by the fact that very little recreation takes place in the area.

A longer lasting impact would be trails resulting from seismic survey operations. Unlike overland moves, seismic operations do not follow the same routes every year and the number of miles of survey line run can vary greatly from year to year. In some years, no surveys would occur. As with trails created by overland moves, these trails do not necessarily develop over the entire survey route; they would be visible for about 2 to 5 years. Because of the many variables involved, it is difficult to make a reliable estimate as to the number of miles of trail that would be visible during anyone summer season as a result of seismic operations. However, oil and gas scenarios state that approximately 250 miles (6,060 acres) of line would be surveyed using 2-D seismic methods, while approximately 10,560 miles (98,880 acres) of line could be surveyed annually using 3-D seismic methods, potentially resulting in several thousand miles of trails. Mobile camp trails could add another 840 miles (3,056 acres) of trails. Although some of the camp train route could be outside of the planning area and could overlap survey line miles.

Under Alternative B, the impacts from exploration would be the same as those under Alternative A. The number of exploration and delineation wells would be 170, and the number of drilling rigs would be six. Drilling would primarily occur over several winter seasons using ice pads, roads, and airstrips. Temporary on-site location of structures (e.g., drill rigs); noise from generators, vehicles, and aircraft; human presence; and associated activity all would have short-term impacts on solitude, naturalness, and primitive/unconfined recreation experiences. These impacts would be expected to be greatest within a 2-mile radius of the drill site, which is an area of approximately 8,000 acres per well site. Accordingly, under this alternative, there would be a temporary loss of solitude, naturalness, or primitive/unconfined recreation over an area of approximately 48,000 acres. This would be equivalent to about 1% of the planning area and the potential effect on recreation opportunities and experience would be further minimized by the fact that most drilling occurs during winter when very little recreation takes place in the area.

In addition to the short-term impacts that result from ongoing exploratory drilling operations, an accumulating summer-season visual concern exists as a result of the greening of vegetation under vacated ice pads, airstrips, and roads. This direct impact to the area's naturalness would be a result of the same conditions that create green trails, the greater availability of moisture and nutrients as ice or compacted snow melts. This greening of the vegetation does not necessarily develop wherever ice pads are constructed or snow is compacted but when it does, it can be very noticeable from the air for 2 to 5 years and somewhat less noticeable from the ground. Another impact at these sites would be vegetation actually being damaged or broken, especially along the perimeter of a pad or edge of a road. Exploratory drilling operations and ancilliary facilities i.e. 170 ice pads (6 acres each), 30 airstrips (11 acres each) and 6,162 miles of ice roads (3 acres/mile) would result in as many as 20,022 acres that would be in a various state of recovery from these impacts.

Exploration wells that do not indicate the presence of hydrocarbons in developable quantities will be plugged and abandoned leaving nothing more than possibly a mound of dirt expected to be no larger than a square foot on the lands surface. Wells that show potential may be "suspended," and capped with what is known as a "Christmas tree" at the surface, especially if the well might be used again for possible oil production. These are essentially permanent impacts (less than 6 feet high), but almost unnoticeable from several hundred feet away.

Effects of Development

Up to 25 production pads, and 162 miles of pipeline that extend beyond the production area are anticipated under Alternative B. While the intensity of impacts would be greatest during actual construction and development of these facilities, remaining structures, human presence, and associated activity and noise all would have impacts on the experience of solitude, naturalness, and primitive/unconfined recreation opportunity during the life of the field. Because production could occur for 10-50 years, impacts would be long term. These long-term impacts are expected to be greatest within 2 miles of a pad or staging area site (or an area of about 8,000 acres).

There would be little if any pipeline associated on-the-ground activity, except during construction and repair. Long-term impacts to recreation values from pipelines would be expected to be minimal beyond about ½ mile. This equates to about 640 acres per mile of pipeline. Under this alternative, there would be a long-term loss of solitude, naturalness, or primitive/unconfined recreation opportunity over an area of up to 303,680 acres (i.e., [8,000 acres/pad x 25 pads] + [640 acres/mile x 162 miles of pipeline]). In addition, it is estimated that long-term surface (i.e. 2 miles from footprint of staging and CPFs) disturbance and consequently impacts to primitive recreation from three staging areas (50 acres each) and six CPFs (90 acres each) including pads, roads, airstrips, gravel pits, and infield gathering pipelines and associated infield gravel roads (250 miles) would impact 246,100 acres (i.e. [9,300 acres/staging area x 3 staging areas] + [9,700 acres/CPF x 6 CPFs] + [640 acres/mile of road x 250 miles]). These impacts combined (549,780 acres), would be equivalent to about 12% of the planning area. Short-term, routine/daily inspection flights also would impact solitude and naturalness along the length of all pipelines as long as they are in use. The potential effect on recreation opportunities and experience would be greatest for development activities because it would entail year-round activity and would thus continue during the summer when most recreational activity in the planning area occurs. Therefore, the effects to recreation use would not be considered a great impact, because they would impact such a small portion of the planning area (11.9%) and because there is such a small amount of recreation use in the area. The actual effects would depend greatly on where development fields were located relative to major watercourses and the Beaufort Sea coast.

Future potential for formal wilderness or wild and scenic-river designation would likely be reduced in limited areas near oil and gas development facilities, but most of the planning area would not be affected.

Effects of Abandonment and Rehabilitation

While abandonment and rehabilitation activities occurred, small number of recreational users in the area of rehabilitation could have their wilderness experience diminished by noise, marred views, and disturbance to animals which they have come to observe (bird-watchers) or harvest (hunters). However, over the long term, these efforts would minimize and impacts to recreation use would likewise be minimized.

Effects of Spills

Most spills would be confined to a pad. Spills not confined to a pad usually are confined to the area immediately around the pad or pipeline. Therefore, effects on solitude, naturalness, or primitive and unconfined recreation opportunities resulting from spills likely would be confined to the same area described above as impacted by the development.

A large spill that would reach a river, especially the Colville River, and move rapidly downstream would have substantial short-term (and possibly long-term) impacts on recreation values.

Effects to Wilderness and Wild and Scenic River Values

None of the identified non-oil and gas activities would diminish requisite characteristics sufficiently to preclude wilderness or wild and scenic river designations in the future.

Potential wilderness values of naturalness and outstanding opportunities for solitude and primitive, unconfined recreation experiences would be affected by long-term development of petroleum resources on as much as 11.9% of the planning area under Alternative B, about the same area that would be similarly affected by Alternative A. In addition, there could be portions of the area that were explored that would experience lesser residual effects that would reduce wilderness values. Despite the lost values, over 4 million acres (88%) of the planning area would likely retain substantial wilderness values. For perspective, the Wilderness Act specifies a minimum of 5,000 acres to qualify for wilderness consideration in most cases.

The "outstandingly remarkable values" that support Wild and Scenic River eligibility for the Colville River include recreation, wildlife viewing, geology and archeology upstream from Umiat, and paleontology and wildlife from Umiat to Nuiqsut. Only a small portion of the Colville River would experience effects to these values from activities associated with Alternative B, primarily from an expected pipeline crossing of the river in an as yet undetermined location. Specified buffer areas would provide substantial protection for the Colville and other rivers, except in the area very near the pipeline crossing. Although pipeline crossings are discouraged in designated Wild and Scenic River areas, they are permissible, when unavoidable, if measures to minimize effects on the river's outstandingly remarkable values are utilized.

Wild and Scenic River designation is not planned or proposed for the Colville River, as noted in **section 3.4.6.3**, but the applicable lease stipulations and ROPs would preserve most, if not all, of the character and values that could qualify the river for designation in the future, if local and state political sentiments should ever determine designation to be favorable. A potential pipeline would not disrupt the requisite "free flowing" nature of the river and, to the degree possible, it would be sited to avoid the areas specific to the "outstandingly remarkable values" noted above. Selection of a river crossing location for the pipeline would require a permit from BLM, which would afford an opportunity for more detailed review of effects on the Wild and Scenic River eligibility of the Colville River.

Commercial Gas Development

Because a gas pipeline would likely be buried and because little recreation occurs in the planning area in the winter when construction would primarily occur, there would be very little impact to recreation from gas development. The exception might be if gas development prompted some development that would not occur if only oil could be developed. In those cases, impacts would be similar to those associated with oil development. Because Alternative B would make more lands available for leasing and development than Alternative A, it is more likely to create some impacts on recreation.

4.4.16.3 Effectiveness of Stipulations and Required Operating Procedures

Although the lease stipulations and ROPs do not specifically address recreation activities and there is no current intention to consider designation of wilderness or wild and scenic rivers in the planning area, many of the performance-based lease stipulations and ROPs required for development of Alternative B would serve to protect recreation values in the area. For example, areas excluded from leasing and several ROPs and lease stipulations address protection of subsistence values and wildlife in the planning area. Also, surface activity and facility development restrictions serve to minimize potentially damaging activity in and near creeks, rivers and lakes. Since wildlife viewing, big game hunting and boating are major factors attracting recreationists to the planning area, these lease stipulations and ROPs associated with Alternative B also serve to protect and preserve recreation values.

4.4.16.4 Conclusion

There would be approximately 2,000 to 3,000 acres in temporary effects on recreation values from activities other than oil and gas exploration and development. Short-term (temporary) disturbance from ongoing oil and gas exploration activities would impact approximately 107,996 acres. The "greening" of vegetation resulting from ice pads, roads, airstrips, and compacted snow would impact an additional 20,022 acres. Most of the combined 128,018 acres could be in a various state of recovery from the "greening" effect. Seismic operations would result in many hundreds to thousands of miles of trails. Short-term impacts such as trails and pads, disturbance from noise, aircraft and other on-going activities would not accumulate.

Oil and gas development would result in the long-term loss of solitude, naturalness, or primitive/unconfined recreation opportunities over an area of approximately 549,780 acres (or 11.9% of the planning area) for the life of production fields and pipelines. The area subject to recreation impacts would be very similar to the impacts on recreation under Alternative A. Lease stipulations to mitigate for these impacts would be similar for both alternatives.

4.4.17 Visual Resources

4.4.17.1 Activities Not Associated with Oil and Gas Exploration and Development

Under Alternative B, impacts to visual resources would result from on-the-ground management activities, such as archaeological collection efforts, field camps, survey work, overland movements, and hazardous and solid material removal and remediation activities and would be similar to Alternative A. The level of non oil and gas activity may increase under this alternative, as a result of general increased interest in the area generated by the potential for more oil and gas development.

Temporary structures (e.g., sleds, tents), vehicles (e.g., Rolligons, tractors), aircraft, human presence, and associated activities would have some minimal short-term impacts on visual resources or scenic quality by creating a contrast to the line, color, and texture of a primarily horizontal natural landscape. The colors of structures and equipment would contrast the white color of the snow-covered landscape and the various hues of greens and browns, and the smooth texture of the facilities would contrast the varied textures of the windswept terrain and the irregular texture of vegetation. Non-oil and gas activities would need to occur within the Foreground-Middleground Zone of the viewshed in order to attract the attention of the casual observer.

A longer-lasting impact would be trails, sometimes referred to as "green trails", resulting from winter overland moves. Between 20 and 60 trains comprised of one to six vehicles and attached sleds could engage in overland travel each year. These trails form when vehicles compact snow and dead vegetative material, resulting in a greater availability of moisture and nutrients for underlying vegetation the following growing season. Visible trails would not necessarily develop over the entire route of the overland move. Vegetation could be damaged along these trails and the tops of tussocks could be scraped off, although current operating procedures would ensure that such damage was an infrequent problem. Trails would be visible for about 2 to 5 years, but some trails may be visible for longer periods of time. However, because they visually modify existing vegetation, rather than introducing something foreign into the viewshed, trails would not produce much contrast to line, form, or texture. The color contrast would be minimal from ground view because of the natural variation in hue, and would be almost nonexistent from more than a few hundred feet away.

4.4.17.2 Oil and Gas Exploration and Development Activities

Effects of Exploration

Under Alternative B, impacts to visual resources from seismic surveys would be the same as Alternative A. The discussion is repeated here for convenience.

Five seismic surveys would occur. Seismic work would occur in the winter using cat trains with low-ground-pressure vehicles supported by light aircraft. Seismic crews would be housed in mobile camps consisting of a train of trailer sleds pulled by tractors along different trails. These moving camps and associated activities would result in short-term impacts on visual resources and the scenic quality of the area by creating color contrast between the vehicles and trailers and the predominantly white background of the snow-covered landscape. These impacts would be confined primarily to the activity-site viewshed.

Trails resulting from seismic survey operations would result in a longer-lasting impact to visual resources. Unlike overland moves, seismic operations would not follow the same routes every year, and the number of miles of survey line could vary greatly from year to year. In some years, no surveys would occur. Like trails caused by overland moves, trails caused by seismic operations would not necessarily develop over the entire survey route, but where present would be visible for about 2 to 5 years, but some trails may be visible for longer periods of time. Approximately 250 miles (6,060 acres) of lines would be surveyed using 2-D seismic surveys, while approximately 10,560 miles (98,880 acres) of lines could be surveyed during each 3-D seismic survey, potentially resulting in several thousand miles of trails. Mobile camp trails could add another 840 miles (3056 acres) of trails. Because trails visually modify existing vegetation, they would not produce much contrast to line, form, or texture. The color contrast would be minimal from ground view because of the natural variation in hue, and would be almost nonexistent from more than a few hundred feet away.

Approximately 170 exploration and delineation wells would be drilled under this alternative, 19 more than Alternative A but 40 less than Alternative C and 23 less than Alternative D. Given the limited number of drilling rigs available however, no more that six drilling rigs would likely be operating at any one time. Drill rigs (average height of 208 feet) would introduce strong vertical lines into a predominantly horizontal landscape. Because they are painted red, most drill rigs would also produce a strong visual contrast to the white background of the snow-covered landscape. Winter drilling requires lighting, which would create a visual contrast

against the dark night sky. Drill rigs, because of their height, could be seen and attract the attention of the casual observer if they were located within the Foreground-Middleground Zone and Background Zone.

In addition to the impacts that would result from ongoing exploratory drilling operations, the greening of vegetation under vacated ice pads, ice airstrips, and ice roads would cause impacts to visual resources during the summer. This greening of vegetation would be caused by the same conditions that create "green trails" — a greater availability of moisture and nutrients as ice or compacted snow melts. However, greening of vegetation would not necessarily occur everywhere ice facilities were constructed or snow was compacted. There would also be a "ring effect" around ice pads, ice airstrips, and ice roads caused by the death of vegetation adjacent to these snow and ice structures. Winter facilities inclusive of 170 ice pads (6 acres each), 30 airstrips (11 acres each), and 6,162 miles of ice roads (3 acres per mile) would result in as many as 20,022 acres that would be in various states of recovery from greening and ring effects under Alternative B (16,768 acres in Alternative A; 23,463 acres in Alternative C; and 20,202 acres in Alternative D). Because greening and ring effects visually modify existing vegetation, they would not produce much contrast to line, form, or texture. The color contrast would be minimal from ground view because of the natural variation in hue, and would be almost nonexistent from more that a few hundred feet away.

Dry exploration wells would be cut off and plugged below ground level and temporally leave only a small area barren of vegetation while exploration wells with production potential would leave behind a marker pipe (also known as a Christmas tree), which would likely be less than 6 feet tall and no larger than a square foot on the surface. This marker pipe would essentially be a permanent impact, but would be almost unnoticeable from several hundred feet.

Effects of Development

Production rigs (two with an average height of 208 feet) would introduce strong vertical lines into a predominantly horizontal landscape. Because they are painted red, most drill rigs would also introduce strong contrast to the natural browns landforms and greens of the vegetation. In addition, burn-off flares and general work lighting would contrast against the dark night sky. Drill rigs, because of their height and color, could be seen and dominate the attention of the casual observer if they were located within the Foreground-Middleground Zone and Background Zone.

It is estimated that long-term surface disturbance from three staging bases (50 acres each), six pump stations (20 acres each) and six CPFs (90 acres each) would impact 810 acres (650 acres in Alternative A; 970 acres in Alternative C; and 810 acres in Alternative D). These facilities would introduce strong vertical lines from buildings into the landscape of predominately soft horizontal lines. There would also be a visual contrast between the simple, regular form of the buildings and the complex, irregular forms of the vegetation. Colors of buildings and materials would be in contrast with the greens, browns, and blues of vegetation and water bodies. Some of the buildings could be up to three stories in height above the tundra, and would attract and dominate the view of the casual observer if located within the Foreground-Middleground Zone.

Production pads (25 at 10 acres each),250 miles of infield roads (1,938 acres), six airstrips (11 acres each), 13 gravel pits (50 acres each), and 250 miles of infield gathering pipelines (760 acres) would impact 3,664 acres (2,818 acres in Alternative A; 4,649 acres in Alternative C; and 4,538 acres in Alternative D). The gravel pads, airstrips and infield roads would generally be only 3 to 5 feet above the surrounding green tundra, and would be relatively unnoticeable

beyond a few thousand feet. Infield gathering pipelines (4-10 inches in diameter) would introduce shiny and smooth horizontal lines into a natural landscape. They would also introduce regularly spaced vertical supports into an irregular horizontal landscape, but would be associated with other facilities within the disturbance area. Disturbance associated with gravel sites from borrow pits or below ground bedrock would generally occur below the ground surface, with only stockpiled materials being visible aboveground. While these sites could be large in size or footprint, very little material would remain as stockpile at any one time. Gravel mine sites from above ground bedrock locations may produce visual impacts if material is removed from rock outcrops within the area. This mining activity would change the form of the natural landscape and may be visible from the Foreground-Middleground Zone.

It is anticipated that as many as 162 miles of sales oil and main pipelines, impacting up to 491 acres (3 acres per mile) would be constructed under Alternative B (162 miles, 491 acres in Alternative A and D, and 182 miles, 551 acres in Alternative C). There would be no on-the-ground activities associated with sales oil and main pipelines, except during construction and repair. Sales oil and main pipelines (12-20 inches diameter) would introduce shiny and smooth horizontal lines into the naturally irregular brown and green landscape. They would also introduce regularly spaced vertical supports into an irregular horizontal landscape. All pipelines would be elevated at least seven feet above the surrounding tundra, but could be elevated as high as 20 feet above ground level. At these elevations, pipelines would attract and dominate the attention of the casual observer if located within the Foreground-Middleground Zone and Background Zone.

Other facilities associated with development would include bridges and communications towers. If located within the Foreground-Middleground Zone, bridges, because of their contrast with smooth water bodies, and communications towers, because of vertical height above the horizon, would also be likely to attract the attention of a casual observer.

Vehicle traffic on roads during construction and other production activities would create short-term noticeable visual impacts through the creation of dust. Summer vehicle travel off gravel pads and roads would be very limited, but may cause changes color from the natural landscape by causing damage to vegetation and possibly the tundra mat. These changes would be limited to the Foreground-Middleground Zone.

Effects of Abandonment and Rehabilitation

During abandonment and rehabilitation activities, vehicle traffic on roads would create short-term noticeable visual impacts through the creation of dust. Gravel pads and roads may or may not be removed and may or may not be revegetated with native species or other appropriate vegetative materials. Once closure and abandonment activities, including revegetation are completed, the strong contrasts with the surrounding vegetation colors created by structures, such as pipelines and buildings, gravel pads, roads and airstrips would be eliminated. If gravel is not removed and not revegetated, long-term color contrasts would remain between the gravel areas and the surrounding natural vegetation.

Effects of Spills

Most small spills would be confined to a pad. Small spills not confined to a pad would usually be confined to the limited area immediately around the pad or pipeline, and usually impact less than five acres. With proper containment and clean-up, there would be no new visual impacts associated with small spills estimated to occur 2,070 times over the life of oil and gas activities

in the planning area under this alternative (1,792 in Alternative A; 2,503 in Alternative C; and 2,287 in Alternative D).

Large spills, estimated to occur about three times during the life of oil and gas activities in the planning area, would likely reach beyond the gravel pad and enter the environment. Impacts associated with visual resources would be to the surrounding vegetation and result in a contrast in color between the affected vegetation and soil, and the natural landscape.

Commercial Gas Development

Impacts to visual resources associated with surface disturbance and surface facilities for development and production of natural gas infrastructure would be similar to those described for oil development, though there would be no impacts from an oil spill. If natural gas production facilities are associated with existing oil infrastructure there would be some additional visual impacts associated with pipeline offset impacting additional acres if gas is transported on separate aboveground VSMs. If a gas pipeline is buried, there would be some change in line, color, and texture. These changes would result from the disturbance of irregular, predominately green, rough vegetation to a more regular, brown, smooth area of soil as seen within the Foreground–Middleground Zone. Facilities associated with a compressor station along a gas pipeline would introduce vertical, blocky, colored facilities similar to CPF structures into a predominately horizontal, green, irregular landscape and be visible within the Foreground-Middleground Zone and the Background Zone from some locations. These facilities would impact additional acres. It is anticipated that Alternative B would create more such impacts because it would make more lands available for leasing and gas development.

4.4.17.3 Effectiveness of Stipulations and Required Operating Procedures

Although there are no ROPs and lease stipulations specific to visual resources, ROPs and lease stipulations designed to minimize impacts to solid and hazardous wastes; regulate overland moves, seismic work, and exploratory drilling; and regulate facility design, construction, and siting would reduce the visual impacts that would occur under Alternative B. In addition, approximately 213,000 acres would be unavailable for leasing and development, further protecting visual values around Teshekpuk Lake. Restricted Surface Occupancy (RSO) stipulations on approximately 977,000 acres will help reduce impacts to visual resources by restricting certain activities associated with exploration and oil and gas development (see Map 2-2).

4.4.17.4 Conclusion

Under Alternative B, as many as 11,650 miles of seismic and camp lines will impact 107,996 acres. This is the same as under Alternative A, C and D. Other temporary facilities such as ice roads, pads and airstrips, associated with exploratory drilling would impact up to 20,022 additional acres. Most of the combined 128,018 acres could be in various states of recovery from greening and ring effects. It is anticipated that up to 412 miles of pipelines would be constructed under this alternative, creating surface disturbance of up to 1,251 acres. There could also be approximately 3,714 acres of disturbance associated with gravel pads, roads, gravel sites, pump stations, staging bases, and Central Processing Facilities. Visual impacts associated with this alternative would be approximately 2.9% of the planning area. Approximately 213,000 acres would be unavailable to leasing and development around Teshekpuk Lake while another 977,000 acres would have Restricted Surface Occupancy stipulations.

4.4.18 Economy

4.4.18.1 Activities Not Associated with Oil and Gas Exploration and Development

Impacts of non-oil and gas activities are likely to be the same as those for Alternative A. Recreational river rafting will occur in the planning area, primarily on the Colville River. BLM estimates (Table 4.2-A) up to 22 trips each made by 4 persons taking place each year. Employment generated by this activity would result from air taxi service and guide service. Neither of these services originate within the planning area. Air taxi services used for Colville River access originate in Bettles, Kotzebue, Fairbanks, and Coldfoot. Guides originate in Bettles, but may also originate from other locales in Alaska outside the North Slope, or may originate outside Alaska entirely.(Delaney 2007) Permitted commercial guided activities will result in fees to the Federal government. Operators or guides pay approximately $600 per year for BLM permits. BLM estimates their clients pay $1,200-$1,500 each for a trip.

Other activities such as research or surveys, various ground activities, and aircraft use not related to petroleum are shown in Table 4.2-A, Summary of Selected Non-Oil and Gas Related Management Activities. North Slope Borough residents may be employed in some of these activities, as will be other Alaskans and nonresidents.

4.4.18.2 Oil and Gas Exploration and Development Activities

In Alternative B, activities will proceed in a manner and order similar to Alternative A. Peak production in this alternative is calculated at 73.5 million barrels in 2051, 2061, and 2071. Up to 6 central processing facilities will be in operation during the life of the fields. Ultimately, about 10% more wells will be drilled compared to Alternative A. The year 2021 initiates substantial production for this alternative (31.9 MM bbl).

Revenues

Bonus bids generated in leasing may total as much as $48.8 million. Approximately 370,000 acres of previously unavailable land will be offered for lease. Exploration, development, and production activities are estimated to generate property tax revenue to the North Slope Borough of about $37 million early in the development of the operation. Other local, state, and Federal revenues are also anticipated to increase under this Alternative. The estimated 2045 royalty payments split equally by the State of Alaska and the Federal government is over $1 billion. State Taxes will be approximately $89 million, and federal income tax will be over $1 billion. In addition, $606 million in state severance taxes could be generated in 2045. These estimates are based upon average imported crude oil prices in 2005 dollars from the Annual Energy Outlook 2007.

Table 4.4-B. Alternative B Revenues (in millions of 2005 dollars)

Alternative /Revenue	Bonus Bids	Royalty		Property Tax		State Tax		Federal Tax		Severence Tax	
Year		2021	2045	2021	2045	2021	2045	2021	2045	2021	2045
B	48.8	325	1,193	37	192	31	90	347	1,015	165	606

Employment

In this alternative we expect 6 exploratory wells each year in five year increments as a lease is explored. Additional fields will also be delineated by exploratory wells ten to thirty years after initial activity. Therefore, long before exploratory drilling is complete, development wells, central processing facilities, roads, pipelines, airstrips, will be under construction. Direct employment will be higher than Alternative A, as high as 3300 by 2045 when three CPFs are operating, a fourth under construction, with wells and infrastructure being added. Indirect employment will mirror the increases in direct employment.

Table 4.4-C. Potential Employment for selected years under Alternative B

Tasks/Alternative	Year	Total Direct	Total Indirect	NSB Direct	NSB Indirect
Survey	2008-9	Same as A	Same as A	Same as A	Same as A
Exploratory well drilling	2010-15	180-360	500-1000	12-24	8-16
CPF, and infrastructure development	2016	400-600	same as A	same as A	same as A
CPF operation development well drilling, sale line construction	2017	500-680	same as A	same as A	same as A
Pad, development wells road, pipe, 3 CPFs in operation, CPF under construction	2045	1600-3300	2000-4100	100-230	80-165

Commercial Gas Development

Natural gas development and production from the NPR-A would generate additional employment. Construction of pipelines would provide substantial numbers of construction jobs for the winter seasons of installation. It is likely that a portion of construction workers would reside in the NSB. Once in operation, gas development would not result in substantial increases in employment over that associated with oil production. However, if gas development occurs as oil production is decreasing or ceasing, the addition or shift to gas production may prolong employment from planning area petroleum production. Development would generate additional property taxes and royalty income for the NSB and State, more severance taxes for the state, and additional royalties for the Federal government. To the extent that industry is attracted to bid on leases for their gas rather than oil production potential, gas development opportunities could increase interest and bid amounts at lease sales within Northeast NPR-A, providing additional revenues for the Federal and state governments. Alternative B offers more land for oil and gas leasing than Alternative A, so it is anticipated to have more impact on employment and revenues than Alternative A.

4.4.18.3 Conclusion

Employment and some of the revenues generated by oils and gas exploration and development would be greater in Alternative B than under Alternative A. By 2045, approximately $192

million would be generated annually in property taxes. The annual royalty would be about the same as in Alternative A. The number of jobs created by exploration, development, and production would peak at 3,600 to 7,400 during 2045. The number of resident jobs generated would be 180 to 395 in the same year. The likelihood for disruptions to the harvest of subsistence resources and associated economic impacts would be greater than under Alternative A.

4.4.19 Public Health

4.4.19.1 Activities Not Associated With Oil and Gas Exploration and Development

Under Alternative B, activities such as baseline data collection, cataloguing of cultural resources, biological monitoring, and the potential for increased tourism because of interest generated by leasing in the area could all lead to short term disturbances. It is not anticipated that these activities would be more frequent under Alternative B than under Alternative A. Thus, the health effects from activities not associated with oil and gas exploration and development under Alternative B would be similar to those described under Alternative A. This type of disturbance could have health effects, but they would also be sporadic and limited to individuals or families. On an individual basis, these impacts could be highly significant. But because the activities not associated with oil and gas development are expected to be short term, localized, and sporadic, they would not be expected to result in overall population health changes.

4.4.19.2 Oil and Gas Exploration and Development Activities

Effects of Disturbances

The public health effects of Alternative B would be similar in nature, but greater in magnitude than those associated with Alternative A. Revenue to the NSB and state may be somewhat higher under Alternative B than the no action alternative, but the difference would likely be spread over many years of development, and thus are not expected to result in marked differences in the annual revenue stream compared with Alternative A. Increases in the amount of area available for leasing and exploration would likely correspond with increases in the reduction of subsistence harvests as discussed in **section 4.4.12**. The development proposed for the planning area would require increased staging and overland travel during the winter, and in summer would require increased use of aircraft for supplies, equipment, and crew changes, as compared to Alternative A. In turn, this would result in a relative increase in presence of oil industry personnel in the villages and subsistence areas. In all seasons, noise, lights, personnel, and traffic near oil and gas-related infrastructure could temporarily deflect or divert caribou in areas where activities are occurring; however, gravel pads could attract caribou during some seasons as insect-relief habitat. These effects could change the distribution, timing, and location of the caribou harvest, which could require increased effort and expenditure, travel time and risk on the part of subsistence hunters, resulting in sociocultural consequences such as increased stress and a decreased sense of well-being.

<u>**1. Diabetes Hypertension, and Associated Metabolic Disorders**</u>

As described in **section 4.3.19**, diabetes, hyperlipidemia, and hypertension – collectively termed "metabolic disorders" here, would result if the proportion of the diet made up of

subsistence foods decreased significantly. Metabolic disorders are disproportionately common in AI/AN groups compared with the U.S. population. However, because of the high consumption of subsistence foods in communities depending on the planning area, rates of diabetes in the North Slope Inupiat are among the lowest in the U.S., including among non-natives (Naylor et al 2003; Bjerregaard and Jorgensen 2004; Zinman; Murphy et al 1997; Young et al 1992; Bjerregaard, Young et al 2004). Hence subsistence constitutes the primary protection against these disorders, and any substantial decrease in subsistence harvest would place communities at higher risk.

Under Alternative B, the most likely impacts to subsistence would be displacement of hunters; displacement of animals from traditional hunting areas as well as population decline resulting from activities in the planning area could also occur. The risk of these problems would be increased in Alternative B compared to Alternative A owing to leasing in a greater percentage of the region, including areas felt to be particularly ecologically sensitive.

Modernization and acculturation pressures also tend to foster a shift toward a 'western' diet, and so the sociocultural effects outlined in **section 4.4.13** could also contribute to a general decline in subsistence intake (Schraer and Bulkow 1993; Curtis, Kvernmo 2005; Nobman, Ponce et. Al 2005; Condon et al 1994).

2. Food Insecurity and Hunger

As described in Alternative A, food insecurity and hunger are serious medical problems even before malnutrition or starvation set in. Impacts to subsistence resources – and the potential for impacts before they actually occur – would be greater under Alternative B than Alternative A. Both food insecurity and hunger would be likely to increase under alternative B if significant decreases in harvest success occur. In such a scenario, kinship and sharing networks could be stretched thin. Replacing subsistence foods with store bought foods would be both extremely costly and far less nutritious; the expense of buying high-quality foods in remote Alaskan villages is often prohibitive (Bersamin, Luick et al 2006; Lamden, Receveur et al. 2006). To our knowledge, there are no cases of severe protein-calorie malnutrition or starvation in Alaska in recent years. This is likely because of the national and state programs such as food stamps and general assistance, as well as kinship and sharing networks, all of which provide a 'safety net.' Under Alternative B, it is not certain whether these programs would be enough to make up for harvest losses if impacts to subsistence were severe. Starvation is felt to be highly unlikely in view of national, state, and NSB support, but malnutrition could occur in the unlikely event of a severe reduction in the availability of subsistence foods.

3. Social Pathology (assault, alcohol and drug abuse, domestic violence, suicide, and homicide)

Social pathology would be more likely under Alternative B than under Alternative A, but would be less likely overall than under Alternative C. Factors which would influence rates include the following. The influx of large numbers of workers and the chance that new roads could be built connecting the planning area with the road system (although roads are not anticipated) would effectively provide routes for more ready importation of illicit alcohol and drugs; this would also place a heavy burden on already taxed local law enforcement. Data shows that social pathology is related to access to alcohol in Alaska Native villages, and that VPSO support in villages can substantially improve well-being (Wood and Gruenewald 2006; ANTHC 2006; Chiu and Perez 1998; Martin 2005). Perceived and actual threats to subsistence (which could be greater under Alternative B), coupled with the industrialization of highly valued subsistence lands, would be sources of increasing stress and tension, factors which would also tend to increase social pathology. This effect could be particularly severe if subsistence sharing networks were

interrupted by the restriction of subsistence. Sociocultural change, or "acculturation," is associated with intense contacts with outside social systems and cultures, such as would occur under this alternative with the influx of oil workers to from outside the region. Rapid sociocultural change is well-established as a cause of social pathology and related health problems in Arctic Indigenous populations (Curtis, Kvernmo et al 2005; Bjerregaard 2001; Wexler 2006). These effects would likely be most intense in Nuiqsut, which lies between the road system and the planning area, but might be experienced by Anaktuvuk Pass, Wainwright, Atqasuk, and Barrow as well as development of the region expands. Interruption of sharing networks, if severe enough, could have effects on other villages as well. Stress produced by the loss of traditionally important hunting range, and the fear of curtailed ability to continue pursuing a subsistence way of life, frustration and feelings of disempowerment regarding land use planning and regulation and the development of important and highly valued subsistence areas, food insecurity, and the longer travel distances and more difficult hunting conditions produced by displacement of subsistence resources and hunters by oil infrastructure would all contribute to increases in stress and social pathology. Rosemary Ahtuangaruak, a former Mayor, community health aide, and physician's assistant in Nuiqsut, described the link between subsistence and social pathology:

> When our people can feed themselves, they're very happy. They don't care if they don't have a job as long as they're providing for their families, as long as they have the hope in their mind of the possibility to provide for their families. You take away that hope, and you're going to have many, many people that we lose to the ills of social ills. (Rosemary Ahtuangaruak, in MMS 2001).On the other hand, data from other populations has fairly consistently shown that economic development and increased employment generally have favorable impacts on rates of social pathology. Travis (1987) showed that in Inupiat communities, the increased risk of suicide caused by rapid modernization and acculturation is mitigated to some degree by economically favorable conditions. Haley (2004) found that strong preexisting economic systems helped a North Slope community cope with the rapid economic change brought by development. One study, however, found that in Inupiat communities, increased employment was not always associated with improved well-being, because of the tensions created between work and subsistence (Martin 2005). However, most North Slope residents tend to view employment opportunities as a positive, particularly if flexibility to allow continued active participation in subsistence can be built into the work schedule.

Overall, the trend toward increases in social pathology would be most dependent on impacts to subsistence traditions, sharing networks, and the degree to which the proposed action results in illicit importation of drugs or alcohol. The stress associated with widespread community fears about the implications of leasing in this area is evident in community testimony, and will likely contribute to social pathology regardless of actual impacts from development in the region. Improved employment and income opportunity would offset these problems to some degree, but overall trends in social pathology would likely mirror the trends toward socio-cultural disruption as described in **section 4.4.13**.

4. Injury

Under alternative B, injury rates could be higher than those anticipated under Alternative A. As summarized in **section 3.4.10** injury is the second leading cause of death in the North Slope, and the leading reason for non-obstetric hospitalization. Injury rates tend to parallel social pathology, reflecting alcohol-related injury, suicide, and rates of violence (ANTHC 2006, injury statistics). Under Alternative B, injury rates would tend to parallel the trend toward increased social pathology described above. Additionally, the potential for displacement of hunters and

subsistence resources could compound this problem, as longer and more difficult hunts would be associated with a higher risk for injury as well.

The public safety system would face additional stresses coping with large numbers of oil workers entering communities and traveling through the region, making it difficult for communities to adequately enforce prohibition laws. Studies in the region have shown a strong association between adequate VPSO support, effective prohibition laws, and decreased injury rates (Wood and Gruenewald 2006).

5. Health Problems related to EPA Criteria Pollutants

Airborne emissions produced by exploration and development under Alternative B are projected to be modestly greater than under Alternative A (**section 4.4.1**). However, we estimate that the overall contribution of emissions to PSD class II requirements would be small. EPA Criteria Pollutants (NOx, SO_2, PM_{10}, $PM_{2.5}$, ozone, lead, and CO) are associated with a range of acute health effects, including exacerbation of chronic lung disease and asthma, increased risk of cardiac arrhythmias, exacerbation of atherosclerotic coronary artery disease, and excess overall mortality, particularly among vulnerable groups such as young children, elders, and people with chronic illnesses. According to the EPA, $PM_{2.5}$ in particular is associated with "increased respiratory symptoms, such as irritation of the airways, coughing, or difficulty breathing, for example; decreased lung function; aggravated asthma; development of chronic bronchitis; irregular heartbeat; nonfatal heart attacks; and premature death in people with heart or lung disease" (EPA 2005).

Current air quality assessments on the North Slope are based on scientific judgment and limited modeling. Both EPA and the State of Alaska have established legal limits for air pollution based on scientific evidence, known as Ambient Air Quality Standards, to protect public health, including the health of sensitive populations such as asthmatics, children, and the elderly. However, according to EPA analysis and several independent studies, substantial health effects accrue at even levels below NAAQS standards, down to ambient levels (Ostro et al 2006; USEPA 2006b). The health effects include higher overall mortality rates and higher loss of 'quality adjusted life years,' a measure which takes into account time lost from illness. From the standpoint of the North Slope population, one of the most important findings of these data is that the impacts fall disproportionately to vulnerable populations (elderly, very young, and people with chronic illnesses. Given the baseline health disparities described in **section 3.4.10**, then, North Slope communities would face substantial risk from increased particulate emissions, even if air quality continued to meet NAAQS standards. The state of Alaska, however, has not yet adopted a standard for $PM_{2.5}$, for which the EPA established regulatory criteria more recently. The deadline for the state to adopt new $PM_{2.5}$ standards is December 2007. Consequently, there are no data available for $PM_{2.5}$ levels on the North Slope.

The NSB has expressed strong concern that the models used to predict air quality on the North Slope have not been adequately validated, particularly in view of the arctic climate conditions. The NSB and AI-TC have further asserted that, because of the health disparities and vulnerabilities in North Slope villages (including the high prevalence of certain cancers and pulmonary disease, as described in **section 3.4.10**), it is critically important to establish a scientifically robust monitoring program to validate the current predictions.

Under Alternative B, given that development would occur closer to actively used subsistence camps and hunting areas, the increased emissions compared with Alternative A may result in a greater risk of exacerbation of chronic pulmonary disease, and cardiovascular and pulmonary mortality among vulnerable groups. However, occasional exposure to acute low air-quality

events is more likely than chronic exposure to poor air quality. Due to the distance of potential development from most population centers, substantial reductions in village air quality is unlikely.

6. Health Problems Related to Other Contaminants

Under Alternative B, development could occur over much of the most important subsistence range in the North Slope region. Emissions would be greater than under Alternative A because of the greater extent of exploration and development-related activities. Oil spills are another route through which contaminants could contact the human population, either directly or through pollution of air, water, and subsistence resources. North Slope residents have expressed concern that development in the Teshekpuk Lake region would pose a particular danger because of its proximity to resources and popular hunting areas.

Public health data support the link between contaminants produced by oil development, and the risk of cancer, endocrine disruption, and cognitive disorders (Jacobsen et al 1996; Arctic Monitoring and Assessment Program 2003; Cone 2005). Data from other communities in which the "total petroleum hydrocarbons" concentrated in water (from air and waterborne sources) has documented a correlation between proximity to oil and gas exploration and production and health outcomes, including cancer and miscarriages (San Sebastian, Armstrong 2001, 2002; Hurtig, San Sebastian 2002.) However, NSB and state monitoring to date has indicated that the subsistence food supply in the North Slope region as a whole is quite safe, and have concluded that the "benefits of a traditional food diet far outweigh relative risks posed by consumption of small amounts of contaminants in traditional foods" (Alaska Native Health Board, 1999).

An accurate determination of specific HAP quantities and potential impacts is not feasible at this stage, given that particular site-specific development activities and pollution controls are not yet able to be predicted. Furthermore, there are few direct data addressing water or air concentrations of many contaminants in the region, nor are there data regarding levels of these contaminants in the human population. HAP are a source of great concern for North Slope residents, who feel that their exposure to contaminants is likely to be significantly greater than the general population because of their extraordinarily high rates of consumption of fish and game which feed in the region.

Thus, although data support the conclusion that the overall benefits of maintaining an active subsistence lifestyle, culture, and diet outweigh the unproven risks posed by North Slope contaminants, data are insufficient to allow accurate modeling of the public health risks under this alternative. The level of predicted development activity and the extent of reliance on resources in the area, however, suggest that there is justification for concern, investigation, monitoring, and efforts to minimize potential routes of exposure.

7. Infectious Disease

As outlined in **section 3.4.10**, the prevalence of pulmonary disease is high; rates of HIV and syphilis are substantially lower in the North Slope than in the Alaskan and U.S. general population (Alaska Department of Public Health 2002 and 2005); Chlamydia rates are much higher in Alaska Natives than non-Natives in Alaska – there are no north Slope-specific data available at this time (Alaska Department of Public Health 2006). In our discussions with health care providers in the region, many commented that the North Slope community appears particularly vulnerable to respiratory infections. This observation has been made in other coastal Alaska Native populations as well (Singleton, Bruden et al. 2006).

Under Alternative B, there would be a greater potential for transmission of infectious diseases than under alternative A, owing to a greater projected level of activity in the region, including greater influx of workers from outside the region (refer to **section 4.4.18**). Transmission of respiratory infectious would be of greatest concern to vulnerable members of the community, including people with chronic illnesses and elders. Under Alternative B, an influx of personnel from outside of Alaska – where HIV and syphilis rates are generally substantially higher – could expose villages to a significant risk of increased incidence of these diseases. The NSB health department has tried in the past to address this problem though sending boxes of condoms to oil camps near villages, but existing resources in the NSB have not allowed a more coordinated public health effort to study or monitor transmission rates, nor to develop a more detailed public health approach to prevention. Diarrheal illnesses, common in groups of workers living and working in small enclosed facilities such as oil camps, could also pose a threat if infection spread to the community. Permanent roads linking the planning area with the road system could be allowed under Alternative B. Although considered unlikely, if constructed, permanent roads could lead to increased travel to and from the planning area, and thus serve as another potential source of exposure to infectious diseases.

8. Social Determinants of Health
Alternative B would be associated with more impact on the social determinants of health than Alternative A. Adverse effects would come from greater impacts on subsistence and sociocultural systems as described in **sections 4.4.12 and 4.4.13**, leading to stress and decreased social capital; there would be greater influx of non-Native employees through the villages (**section 4.4.18**), leading to acculturation stresses; there would be a tendency toward more problems of addiction, as described under "social pathology" above; if the increased development activity anticipated under this scenario translates into increased income to local native corporations, there could be increases in relative income disparity within villages; and there would be feelings of frustration, loss, disempowerment, and anger over the industrialization of a region of special and unique importance to Inupiat culture. Referring to Table 4.3-D, these issues would impact social determinants including the social gradient, stress, social capital, and culture, income inequality, and environmental quality, all of which have well-documented public health implications.

There would be substantial benefits as well. Increases in employment and income would tend to benefit community well-being, particularly if local communities are able to work out adequate provisions for subsistence leave; income would also facilitate subsistence. As stated previously, the funding for infrastructure, public safety, and public health, as well as employment in the NSB comes almost entirely from oil and gas development, and this alternative would offer greater revenue to continue these programs.

Thus it is possible to identify both positive and adverse impacts to the social determinants of health from Alternative B. Given the central importance of subsistence to community well-being, if subsistence livelihoods are impacted such that communities are forced to substantially reduce their reliance on subsistence, it is likely that there would be an overall adverse impact on communities.

Effects of Abandonment and Rehabilitation

The North Slope economy and citizens have become heavily dependent on revenue from oil and gas development. Under Alternative B, revenue, employment, and income related to development would be higher than under Alternative A (see **section 4.4.18**). This could lead to greater dependence on economic resources, and a shift in the balance of the "mixed wage work-

subsistence" economy. After the termination of development, revenues to the NSB and local Native corporations could decline considerably. The rehabilitation work available may lead to a transient increase in employment, but this could be followed by a period of significant economic contraction, both because of decreasing NSB revenues and because of loss of direct jobs. As noted previously, economic depression and job loss are strongly associated with social pathology, which would likely increase during this period. It is possible that subsistence resources could become more readily accessible after a period of adjustment, but this must be viewed as highly speculative in view of the baseline of rapid ecosystem change. If this occurred, it would help offset effect of decreasing capital available for purchase and repair of hunting equipment and fuel purchase. The decline of these revenues is likely to have profound effects. It is not at all clear whether people will be able to resume their pre-development way of life, whether subsistence resources will have become depleted, contaminated, or displaced, or how people will continue to support a lifestyle which depends heavily on modern technology. Viewed from the perspective of the social determinants of health, this period will have substantial implications for health given the large-scale economic and employment transition anticipated. Another concern would come from the potential leakage of contaminants from wells and dumpsites: residents have expressed concern that if the area is less stringently monitored after development ceases, contamination of rivers, lakes, and estuarine habitats could ensue and would be missed, with substantial implications for human health.

Effects of Oil Spills

Oil spills can affect human health in a number of ways. Direct contamination can produce toxicological effects; rashes and respiratory symptoms have been documented after acute exposure (Lyons, Temple et al. 1999). Longer-term effects from contamination of subsistence resources by organic compounds such as polycyclic aromatic hydrocarbons could lead to chronic exposure-related illnesses such as cancer, birth defects, miscarriages, and endocrine disruption (AMAP 2002; San Sebastian, Armstrong et al. 2001, 2002). Social and psychological effects of large oil spills are also a significant source of morbidity. Residents in the vicinity of an oil spill have been shown to have higher rates of anxiety disorder and post-traumatic stress disorder (Palinkas, Petterson et al 1993; Lyons, Temple et al 1993). A large oil spill could result in a significant decrease in subsistence activity, as was seen after the Exxon Valdez oil spill. In turn, this would to marked changes in social organization, decreased social capital, decreased consumption of subsistence foods, and an attendant increased risk of social pathology, injury, and diabetes and metabolic disorders (re. social capital and EVOS: Ritchie and Gill 2004). The magnitude of these problems would depend largely on the extent of the spill, and the degree to which it impacted local subsistence resources. Under Alternative B, the risk of a large spill is estimated to be mildly increased compared with Alternative A, raising the chance that some of these health problems could occur.

4.4.19.3 Effectiveness of Stipulations and Required Operating Procedures

When considering the effectiveness of stipulations and ROPs in mitigating public health effects, it must be recognized that because the Inupiat people continue to value this land deeply as a foundation of well-being and culture, any measure which contributes to minimizing the environmental impacts of development in the region can be seen as contributing positively toward overall health and well-being. On the other hand, North Slope residents and the North Slope Borough have expressed a great deal of concern that the new "adaptive management" strategy adopted in Alternatives B, C and D may result in considerable weakening of protections for the area, and well as creating a situation of perpetual flux and uncertainty as the increased flexibility offered under the new system creates the opportunity for important

protections to be overridden by economic and industry concerns. Hence, from this perspective, the entire adaptive management program may be seen as a significant stressor, with the attendant health problems as described in **section 4.4.19.2** on social determinants of health above.

ROPs A-1 though A-3 and A-5 establish standards for handling of waste and fuels, and through the environmental protection they afford would lessen the risk of environmental or subsistence resource contamination, thereby protecting health. ROP A-4 and E-4 would help with prevention and response to oil spills. To the extent that these measures prove effective in preventing contamination of the environment through oil spills, they would protect human health through preventing exposure to contaminants and protecting the availability and safety of subsistence resources. ROPs A-6 and A-7 establish restrictions on discharge of contaminants in waste from the development phase, and again, to the extent that they prevent environmental contamination would prevent contaminants from causing health problems through contact with the human environment. ROP B-1 and B-2 and Stipulations D-1, E-1 through E-3, and E-6 would help to protect fish habitat and subsistence fisheries. Stipulation D-2 would prevent permanent facilities, thereby conserving habitat for subsistence resources, with the resultant effects. However, the standard only applies if it is economical not to build permanent facilities, hence offering a significant chance that a lessee will be able to build permanent facilities as needed, and weakening the protection offered. ROP E-1 would allow construction of permanent roads between the road system and the planning area, which could entail significant impacts on subsistence resources and, if the roads pass through or near local communities they could also create substantial social strain and social pathology. Road design is required to attempt to create minimal environmental impacts. ROP E-7 would attempt to minimize obstruction of caribou migration and subsistence hunters through raising pipelines a minimum of 7 ft. Stipulations K-I through K-8 establish protections in biologically sensitive areas, through such methods as setbacks from lakes and rivers, RSO requirements, and limitations on where and when activities such as flights can occur. To the extent that these measures actually result in protection of the environment and subsistence resources in the planning area, they would reduce the risk of metabolic disorders (because subsistence diets would be less impacted), social pathology (because there would be less disturbance to campsites, cabins, and hunters), injury (both directly because subsistence resources might not be displaced as far, and indirectly, because maladaptive coping such as alcohol and drug abuse might be less).

ROPs H-1 and H-2 would establish a consultation process to attempt to lessen conflicts between local inhabitants and industry over activities which might restrict subsistence or disturb residents in campsites and cabins in the area. To the extent that conflicts are successfully mediated through this measure, it would help prevent subsistence-related health problems and social pathology. However, it would also create a substantially increased burden on communities, who would be called on frequently during the planning and development process to participate in consultation to protect their interests. The increased stress involved could lead to increased pathology.

ROP I-1 establishes an orientation program designed to educate and inform industry employees regarding the local environment, regulations, and culture of the Inupiat people. To the extent that a single annual orientation program is capable of changing human behavior, this ROP may be effective at minimizing cultural conflicts between Inupiat residents and oil workers.

Overall, the extent to which the Stipulations and Required Operating Procedures for Alternative B mitigate human health concerns will depend on the degree to which the flexibility they provide is enforced to protect the local environment; to the degree to which they prevent

impacts to subsistence resource populations, displacement of subsistence resources, and displacement of hunters and their families; on the efficacy of controls on environmental contamination, on measures to reassure the community regarding their concerns about environmental contamination; and on the degree to which they prevent the adverse consequences of sociocultural change and support the positive aspects associated with employment and economic opportunity. Overall, however, in the face of expanding development, particularly with the development of important subsistence areas, it is likely that there would be substantial unmitigated impacts to health and the social determinants of health.

4.4.19.4 Conclusion

Under Alternative B, the possibility of public health impacts would be substantially increased compared with Alternative A, but overall less than under Alternative C. These impacts would occur primarily through restriction in subsistence; influx of large numbers of outside workers; new access routes to the community; sociocultural and economic change; altered employment; and contaminants. Diabetes, hypertension, and related metabolic disorders would be expected to increase as subsistence is curtailed or as sociocultural changes lead to alterations in dietary patterns. Given that Alternative B involves substantially more development in and near particularly sensitive habitat and hunting and fishing areas than Alternative A, the risk of dietary change and the resultant increases in metabolic disorders would appear to be significantly greater. Cancer, lung disease, endocrine disruption, and neurodevelopmental delay are related to contaminants common to oil and gas development. Although at present no evidence exists to conclusively link rates of any of these problems to local oil development, because of both the increased total emissions projected under this Alternative, and the location of operations within an important subsistence area, the risks of these problems may be increased under Alternative B. Mitigation includes stipulations which regulate discharges, and permits to comply with ADEC and CAA provisions. Social pathology could result from the economic changes anticipated; from increasing access to drugs and alcohol; and from stress and maladaptive coping given the impacts to wider regions of important traditional use areas. Required Operating Procedure I-1, which corresponds to Lease Stipulation 63 of Alternative A and which mandates a cultural orientation program, and stipulations and ROPs that protect subsistence resources would be partially effective, they could not offset the large-scale socio-economic impacts discussed in the preceding sociocultural and public health sections.

4.4.19.5 Potential New Mitigation Measures

The potential mitigation measures for Alternatives B through D are essentially the same as those presented for Alternative A in **section 4.3.19.5**. In Alternative A, they are presented as potential new stipulations, consistent with the approach for protective measures in Alternative A. In Alternative B through D, they would be considered as potential new ROPs. They are listed below in their ROP form. The benefits of these ROPs and the residual and unavoidable impacts for these potential mitigation measures for this alternative are similar to those described for Alternative A, and are described in comparison to those for Alternative A at the end of 4.4.19.5.

1) Health Advisory Board

<u>Potential Mitigation Measure (New ROP)</u>

<u>Objective:</u> Provide for consideration of public health impacts and mitigation of potential public health impacts when considering future major development proposals.

Requirement/Standard
The NSB or other North Slope-wide representative entity could lead the establishment of a body, which could be called the North Slope Health Advisory Board (HAB), with public health expertise and/or responsibility related to the North Slope. This body could 1.) offer advice to better coordinate and design public health research on the North Slope, and 2.) review major development proposals and suggest health mitigations to proponents and permitting agencies, including BLM.

Upon establishment of a HAB, BLM would formally confer with the HAB as a primary source of public health advice on activities with potential impacts on public health. (BLM may also confer with other sources of recognized public health expertise). BLM would require lessees in proposals for permanent facilities within the planning area to provide the HAB or any other source of recognized public health expertise identified by the AO an appropriate analysis of potential public health impacts of the proposal and means proposed to mitigate these impacts as part of their development plan. BLM would also analyze public health impacts and potential mitigation measures in any NEPA analysis examining such a proposal.

2) Subsistence

Potential Mitigation Measure (New ROP)
Objective: Avoid impacts to subsistence harvests.
Requirement/Standard
Initial Study: Before authorization of construction of permanent facilities, the lessee shall design and fund studies, in consultation with affected communities, to: a.) determine the historic and current use of resources dependent on proposed development area, and b.) the significance of the proposed development area to caribou and any other species important to subsistence food intake. The study is to serve as a basis for monitoring impacts to subsistence food harvest that may be caused by the lessee's development. The lessee shall submit study proposals to the NSB for review and comment, including the adequacy of the area and timescale of the studies. The lessee is also advised to consult with the NSSI or relevant constituent members to reduce potential duplication of effort. Studies should be designed to address the potential confounding factors such as reporting inaccuracies common to harvest studies. Lessees are encouraged to cooperate or contract with local entities such as the NSB or ICAS to facilitate accuracy of the data collected. A proposed study design along with any comments received on the study from the NSB and other state and Federal agencies with relevant expertise on the study proposals shall be submitted to the AO. The design of the studies must meet the approval of the AO. The studies should cover a sufficient time such that, in conjunction with other studies, they provide reliable information about the importance of the proposed development area to subsistence harvests (generally will be presumed to be approximately 3 years in length). The results of the studies shall be submitted as part of permit applications and be used in the development NEPA analysis, including in proposing alternatives and mitigation. The AO may waive this requirement if, after considering comments by the NSB and relevant state and Federal agencies, he/she determines that either (1) the research duplicates other efforts, (2) the research will not benefit the communities that depend on the region for subsistence, or (3) the research will cause an undue burden on the community(ies) that depend on the region for subsistence.

Continued Subsistence Monitoring: During construction, operation, and abandonment, the lessee shall, subject to the same waiver provisions applicable to the initial study, conduct studies of current subsistence use of the development area, the harvest of caribou and other subsistence foods from the area, the trends in such use and harvests, and any impacts to

caribou and other species important to subsistence food intake that would affect their availability for subsistence users. The AO may require/authorize changes in the design of the studies throughout the period, or terminate or suspend such studies if results warrant.

Mitigation of Subsistence Impacts: If between the commencement of construction and approval of completion of abandonment measures, the AO determines that the lessee's actions are causing or have caused a reduction in subsistence harvests, the AO may require changes in construction, operations, or abandonment activities. These changes may include restrictions on intensity and timing of activities, including temporary cessation of activities, and any and all other practicable measures that could reduce impacts. The restrictions, however, may not so restrict the lessee's activities to preclude exercise of the rights of the lease. Continued subsistence monitoring will be used to evaluate the effectiveness of these mitigations.

3) Public Health Monitoring

Potential Mitigation Measure (New ROP)
Objective: Avoid adverse public health impacts.
Requirement/Standard
In consultation with appropriate experts, including the NSB, lessee will fund the design and implementation of a public health monitoring study. The study will involve selection of a limited set of public health indicators, chosen for their ability to detect changes in health and social conditions, and routine monitoring of these indicators. The study shall include a minimum of three years of pre-development data and continue over the life of the development. Results will be reported semiannually to the AO, who, with appropriate consultation with public health experts or the HAB (once established), will utilize this information to inform performance-based management decisions involving activities within the planning area.

4) Control of Contaminant-related Health Risk

Subsistence Food and Habitat monitoring

Potential Mitigation Measure (New ROP)
Objective: Avoid substantial health risks to local human populations from ingestion of contaminated subsistence foods.
Requirement/Standard
Initial Study: Before authorization of construction of permanent facilities, the lessee shall design and fund a baseline study to determine the level of contaminants, such as benzene, toluene, ethyl benzene, xylene, and PCBs, commonly associated with oil production, in subsistence food species and their habitat. The study should examine species and habitat potentially impacted by contaminants by the lessee's proposed development. The lessee shall consult with relevant Federal, state, and NSB agencies. A proposed study design shall be submitted to the AO. The AO may consult with appropriate Federal and State agencies with regulatory authority over the release of such contaminants prior to approving the study design. The design of the study must meet the approval of the AO. The study should cover a sufficient time such that, in conjunction with other studies, they provide reliable information about the existing level of contaminants. The results of the studies shall be submitted as part of permit applications and be used in the development EIS, including in proposing alternatives and mitigation.

Continued Contaminant Monitoring: During construction, operation, and abandonment, the lessee shall conduct studies designed to detect any contamination of subsistence foods by the oil

and gas development. These studies shall be subject to approval by the AO. The AO may require/authorize changes in the design of the studies throughout the period, or terminate or suspend such studies if results warrant.

Mitigation of Contaminant Impacts on Subsistence: If between the commencement of construction and approval of completion of abandonment measures, the AO determines that the lessee's actions are causing or have caused levels of contaminants that pose a substantial health risk to subsistence resource users, the AO may require changes in construction, operations, or abandonment activities. The AO will consult with appropriate Federal and State agencies with regulatory authority over the release of such contaminants. BLM may defer to these other agencies, but may independently require mitigative actions. Continued contaminant monitoring will be used to evaluate the effectiveness of these mitigations.

5) Air Quality Monitoring and Management

Potential Mitigation Measure (New ROP)
Objective: Prevent unnecessary or undue degradation of the lands and protect health.
Requirement/Standard
Prior to initiation of a NEPA analysis for an application to develop a CPF, production pad/well, airstrip, road, gas compressor station, or other potential air pollutant emission source, the lessee shall identify background air quality and meteorology data to be used in predicting potential future air quality conditions resulting from the proposed action and other Reasonably Foreseeable Future Actions. If these data can not be estimated, then in the case of a proposed CPF or other facility with potentially large impacts on air quality, one year of on-site monitoring (subject to BLM review and approval) will be conducted to obtain such data. In addition, the lessee shall prepare (and submit for BLM approval) a complete list of reasonably foreseeable air pollutant emissions, including, but not limited to criteria and hazardous air pollutants. Depending on the levels of anticipated emissions, and potential for cumulative air quality impacts, the BLM may require complete direct/indirect/cumulative air quality modeling for the operation phase of the proposed facility. The modeling shall at a minimum compare predicted impacts to all applicable local, state, and Federal air quality standards and increments, as well as other scientifically defensible significance thresholds (such as impacts to Air Quality Related Values, incremental cancer risks, etc.). Depending on the significance of the predicted impacts, a lessee proposing a CPF or other facility with potentially large impacts on air quality may be required to monitor air pollutant emissions and/or air quality impacts for at least one year of operation. Depending upon the initial monitoring results, the AO may also require additional monitoring. If monitoring indicates impacts would cause unnecessary or undue degradation of the lands or fail to protect health (either directly or through use of subsistence resources), the AO could require changes in the lessee's activities at any time to reduce such emissions, such as, but not limited to, use of cleaner-burning fuels or low-emission compressors.

6) Public Safety and Infectious Disease

Add the following subparagraphs to ROP I-1:
k. Include a module designed to ensure strict compliance with local and corporate drug and alcohol policies. This module should be offered to the NSB Health Department for review and comment.
l. Include a module developed to train employees on how to prevent transmission of communicable diseases, including sexually transmitted diseases, to the local communities. This module should be offered to the NSB Health Department for review and comment.

7.) Oil Spills

Potential Mitigation Measure (New ROP)
In the case of a spill of a size and under circumstances that indicate a potential for substantial impacts to subsistence resources, and upon the direction of the AO, lessee shall fund the institution of a scientific review panel to advise the AO regarding monitoring of the effects of the spill on populations of subsistence resources, harvesting of subsistence resources, and contaminant levels in subsistence resources. The AO will appoint members to the scientific review panel with expertise in biological and social sciences as well as in public health. The AO will determine what monitoring is to be required and how long such monitoring shall continue. The lessee shall fund all monitoring. The AO will establish requirements in consultation with other Federal, state, and local authorities with authority to require post-spill monitoring and remedial actions.

Potential Benefits and Residual/Unavoidable Impacts

Under Alternative B, these measures would have similar benefits in terms of the range of public health effects they address. Measures 1 and 3 would establish a framework to ensure that potential public health effects are adequately evaluated during the planning process, and establish a mechanism for ongoing monitoring of public health effects. Owing to the greater extent of development predicted under Alternative B, these measures would provide similar but greater overall benefits than those described under Alternative A. Because development would be allowed over a greater region and within particularly important subsistence regions, however, there may also be greater residual overall health effects. Measure 2, Subsistence Harvest monitoring, would provide relatively greater benefit than that described under Alternative A, because of the greater potential for impacts to subsistence under Alternative B, but again with a potential for greater residual effects. Measure 4, Control of Contaminant-Related Health Risk, would provide protection for contaminant-related health problems as well as helping to reassure communities of the continued safety of subsistence resources. Because, under Alternative B, development would be allowed in critically important subsistence areas, this measure would provide relatively greater benefit than under Alternative A. Certainly though, given the greater extent of development, there could also be greater residual impacts, including both contaminant-related health problems, and problems related to decreased consumption of subsistence resources (including metabolic disorders and food insecurity, and social pathology and injury rates). Measures 6 and 7, through adding health concerns into required orientation programs for industry employees, would have equivalent benefits under Alternative B to those described under Alternative A. Owing to the slightly increased risk of oil spills under Alternative B, measure 8 would offer proportionally greater protection.

Potential Effects on Oil and Gas Development

The expense of the above potential mitigation measures varies widely, from insignificant to potentially millions of dollars. To the extent that the potential mitigation measures would add expense to oil and gas activities, they could discourage leasing, exploration, and development of oil and gas.

4.5 ALTERNATIVE C

4.5.1 Air Quality

4.5.1.1 Activities Not Associated With Oil and Gas Exploration and Development

Air quality impacts associated with these activities are the same as those associated with Alternative A, discussed in **section 4.3.1.1**.

4.5.1.2 Oil and Gas Exploration and Development Activities

The Air Pollutant Emission Sources, Effects of Air Pollution, and Native Views on Air Emissions are the same as those associated with Alternative A, discussed in **section 4.3.1.2**.

Air Pollutant Emissions

Air pollutant emission estimates for Alternative C were based on the following information sources:

1) Helicopter emissions were based on the Federal Aviation Administration's Emissions and Dispersion Modeling System (EDMS version 4.1) for a Bell 206 (Edwards, 2007);
2) Emission estimates developed for the Alpine Satellite Development Plan (USDOI BLM, 2004c) for satellite well pad/access road construction, fixed wing aircraft flights, drilling rigs, and specific production equipment (satellite heaters, field generator, and a CPF turbine); and
3) Actual 2006 air pollutant emissions from the ConocoPhillips Alpine Production Facility (Poteet, 2007).

These emission factors were adjusted for the following assumed activities under Alternative C:

1) Helicopters: 5,000 one-hour flights per year;
2) Exploration/Delineation: up to 144 fixed wing flights per year, 120 exploration wells and 90 delineation wells, 8 drill rigs;
3) Construction: 3,395 fixed wing flights per year, 2 drill rigs, 4,649 acres of land disturbance; and
4) Production: 672 fixed wing flights per year, 32 satellite well pads, 7 Central Production Facilities, and 74 MMbbl peak annual oil production.

Based on these emission factors and anticipated activity, the maximum annual emissions (in tons per year) by activity phase are presented in Table 4.5-A.

Development and production activities can also produce fugitive dust emissions (primarily as PM_{10}). Fugitive dust occurs primarily during the summer months due to driving on unpaved roads. Vehicles can also track out fine material from gravel mining operations in the winter and summer months. Potential control measures include limiting vehicle speeds, and treating problematic road sections with surfactants or water.

Well closure, abandonment and rehabilitation activities would emit air pollutants similarly to those during development (construction), since similar vehicles and other emission sources

would be used. Because closure activity would not occur at a single location for any substantial length of time, the impact of air emissions at any single location would be minor and short term. Impacts could be minimized by leaving gravel on-site, limiting the amount of transport. Once reclamation is complete, production facilities would no longer impact North Slope air quality.

In comparison, a site-specific air quality impact analysis was conducted for the off-shore Liberty Project (USDOI MMS, 2002), which would be somewhat smaller than a typical field that could be developed in the planning area, which demonstrated ambient air quality levels would be close to, but within applicable PSD Class II increments. The combined facility concentrations plus background were predicted to remain well within the ambient air-quality standards (between 2 and 30% of the standards). Because Alternative C facilities would have similar air emissions as those predicted for the Liberty Project, it is likely potential satellite well pads and central production facilities would have similar air quality impacts. the accuracy of determinations of specific air pollutant emissions and potential impacts is necessarily limited at this stage, given that particular site-specific development activities are not yet able to be predicted.

Since CO_2 has not been regulated as an air pollutant, potential CO_2 emissions were not quantified for Alternative C. However, assuming an average 98% combustion efficiency, the CO emissions reported in Table 4.5-A may be multiplied by 80 to estimate equivalent CO_2 emissions (a maximum of 27 x 10^4 tons per year.) However, when compared to estimated worldwide emissions of CO_2 (nearly 28 x 10^9 tons per year), Alternative C would contribute minuscule amounts of CO_2 emissions to global levels.

4.5.1.3 Effectiveness of Stipulations and Required Operating Procedures

No air quality lease stipulations or ROPs were included for Alternative C. Potential air quality impacts from site-specific development activities would be limited based on air quality permits issued by the ADEC and EPA, including applicable control technologies.

4.5.1.4 Conclusion

Air quality impacts from Alternative C are likely to remain below applicable ambient air quality standards and increments, therefore no significant impact to air quality is expected. Air pollutant emissions associated with Alternative C are approximately 38 to 40% greater than Alternative A (No Action), and more than Alternatives B and D. Each new exploration or development activity, or production area, would result in an additional air pollutant emissions. However, the accuracy of determinations of specific air pollutant emissions and potential impacts is necessarily limited at this stage, given that particular site-specific development activities are not yet able to be predicted. As exploration and development activities cease, or production sites are shut-in, there would be a corresponding decrease in air emissions.

Table 4.5-A. Alternative C Air Pollutant Emissions from Surface Activities (tons per year)

Activity Phase	Carbon Monoxide	Nitrogen Oxides	Particulate Matter [1]	Sulfur Dioxide	Volatile Organic Compounds
Helicopters	10	1	1	<1	<1
Exploration/ Delineation	47	213	11	24	<1
Construction	105	396	28	31	34
Production	3,200	16,758	393	533	378
Total	3,363	17,369	432	588	413

Source: Archer, 2007

[1] Combustion sources primarily emit $PM_{2.5}$ while land disturbance primarily emits PM_{10}.

4.5.2 Paleontological Resources

4.5.2.1 Activities Not Associated With Oil and Gas Exploration and Development

Under Alternative C, the types of non-oil and gas activities would be the same as those described for Alternative A; however, there would likely be an increase in the level of aircraft and survey activity associated with environmental studies and monitoring. Despite increased activity, the impact to paleontological resources, which are deeply buried, would still be minor.

4.5.2.2 Oil and Gas Exploration and Development Activities

Under Alternative C, the level of seismic activity is expected to be similar to that of Alternative D and Alternative B. While the types of impacts to paleontological resources would remain the same as for Alternative A, the increased level of seismic activity would increase the potential for impacts to occur. In the areas open to exploration under this alternative, the deeply buried context of most paleontological remains generally precludes any major impact to the resource. Any impacts associated with the increased seismic activity are expected to be minor.

Significant paleontological resources (primarily vertebrate fossils) are not ubiquitous in the planning area. These resources are exposed primarily through erosion (stream cuts, bluff faces, etc.), elsewhere they are usually deeply buried. As a result, the location of exposed material can be to some degree predicted and therefore avoided while the remainder is protected by its depth of burial.

Effects of Disturbances

Under Alternative C, the level of activity in the planning area would increase. However, because most of the activity would occur during the winter months, the potential for impacts to paleontological resources is extremely minor. The likelihood of impacting surface paleontological material also is minor due to their isolated and rare occurrence.

The drilling as many as 210 exploration and delineation wells could occur under Alternative C, a nearly 50% increase over Alternative A. However, it is unlikely that more than eight drilling rigs would be operating at any one time. The drilling activity would occur over the span of many seasons, and drill pads, camp pads, roads, and airstrips made of ice and snow typically would be utilized. Permanent pads, roads, or airstrips could be constructed; therefore, ground disturbance could occur and buried paleontological material could be impacted. The other substantial subsurface disturbance that would occur as a result of the actual drilling would be the making of the drill hole itself. Drilling the borehole could impact scientifically important paleontological material; however, the likelihood of that occurrence is small.

Disturbance from production and service wells, drill pads, staging bases, airstrips, gravel pits, and mainline and gathering pipeline could occur under Alternative C. The amount of area impacted by these activities would be almost 50% more than Alternative A. Surface disturbance resulting from this work could impact as much as 4649 acres, but subsurface impacts associated with these activities would be minor. The primary impact to paleontological resources would result from the excavation of material for construction of the permanent facilities. It is anticipated that a pipeline would not have associated all-weather roads or pads and would be constructed during the winter months from ice roads and/or pads. Therefore, the only substantial impact resulting from pipeline construction would be associated with the placement of VSMs. Depending on the depth at which the VSMs are set it is possible, but highly unlikely, that paleontological resources would be impacted. Overall, ground disturbance from development has a minor impact on paleontological resources.

It is unlikely that paleontological resources would be impacted by abandonment activities, as these localities would have been previously examined for the presence of paleontological resources and have been disturbed by the previous construction and development activities.

Effects of Spills

Under Alternative C, the effects of spills on paleontological resources would be the same as discussed under Alternative A. If present, surface paleontological material could be impacted; however since the occurrence of paleontological remains is rare, the probability of an impact is very low.

Commercial Gas Development

The types of impacts on paleontological resources that natural gas development and production would cause would be similar to that described for Alternatives A and B, but larger because it is anticipated that approximately 20 miles more of buried pipeline would be built. Thus, it is anticipated that burying the pipeline would result in digging up approximately 182 miles of four feet wide and five feet deep trench (approximately 90 acres) and potential surface disturbance of 240 acres in areas adjacent to the trench from potential disturbance from machinery or placement of backfill.

4.5.2.3 Effectiveness of Stipulations and Required Operating Procedures

As discussed under Alternative B, the ROPs and lease stipulations under Alternative C would be highly effective in protecting known and previously unknown paleontological resources and preserving their research potential and, ensuring that impacts to paleontological resources would be minor.

4.5.2.4 Conclusion

The types of impacts to paleontological resources from activities not associated with oil and gas exploration and development would be similar in nature to what has been described previously. Based on the amount of surface area disturbance, the potential impacts to paleontological resources from oil and gas exploration and development could increase about 50% from levels associated with alternative A. Impacts could be greater if exploration and development occurred in an area with abundant paleontological resources. However, the ROPs and lease stipulations proposed to protect paleontological resources under this alternative would be highly effective.

4.5.3 Soil Resources

4.5.3.1 Activities Not Associated With Oil and Gas Exploration and Development

Various types of activities not related to oil and gas leasing and development, including private or commercial air traffic, use of OHVs, recreational camps, paleontological and archaeological excavations, and overland moves could affect soil resources in the planning area under Alternative C.

Under Alternative C, impacts associated with non-oil and gas activities would be similar to those described under Alternative A for all alternatives. These activities could occur throughout the planning area and would be little affected by the increased availability of land for oil and gas leasing.

4.5.3.2 Oil and Gas Exploration and Development Activities

The following analysis is based on **section 4.2.1.2, *Oil and Gas Exploration and Development Activities***. See that section for a discussion of estimates and assumptions for development as well as a description of how estimated areas of disturbance were calculated for each alternative.

During oil and gas exploration and development, various activities could cause impacts to soil resources in the planning area. These activities include seismic activities; construction and use of gravel pads, gravel roads, gravel airstrips, and pipelines; excavation of material sites; construction of ice roads and ice pads; and summer tundra travel. Impacts could also occur from oil spills and from removal of gravel pads and gravel roads during rehabilitation. These activities would impact soil productivity and could alter the moisture regime of tundra near the structure by changing natural drainage patterns and areas where snow accumulates. Types of impacts to soils from oil and gas activities in Alternative C would be similar to those described for Alternative A. Differences in the magnitude and area of impacts for Alternative C are described below.

Effects of Disturbances

Seismic Surveys. Effects to soils from seismic surveys would be the same as for Alternative A. Under all of the alternatives, it is projected that three 2-D and two 3-D surveys would be done to fill in gaps in existing surveys.

Exploration. It is anticipated that under Alternative C there would be a greater number of exploration and delineation wells drilled than under the other alternatives. This could result in greater impacts to soils from the construction of both multi- and single-year ice pads. The area of soil directly impacted by a typical ice pad (500 feet by 500 feet) would be approximately 6 acres. Under Alternative C, it is assumed that 120 exploration wells and 90 delineation wells, or a total of 210 wells, would be drilled from ice pads in the planning area. Impacts to soils could occur on approximately 1,260 acres (210 ice pads x 6 acres/ice pad) over a period of about 25 years (Table 4.2-G). However, some of these wells could be located on Teshekpuk Lake, reducing the total area of direct soil surface disturbance.

Ice road construction, probably up to 50 miles per year impacting approximately 212 acres/year, could also be greater under Alternative C in terms of total miles constructed. For Alternative C, it is estimated that a total of 7,200 miles of ice road would be constructed during the life of the plan for exploration and development impacting approximately 22,000 acres (Table 4.2-G). In addition, approximately 40 miles of ice runway would be constructed impacting approximately 440 acres.

The construction of well cellars during exploration requires digging a hole that would impact approximately 16 square feet (0.0004 acres) of ground for each well. Total area disturbed by digging well cellars under Alternative C would be approximately 0.08 acres (210 wells x 0.0004 acres per well). Thermokarst associated with the disruption of the thermal regime in the surrounding soil could occur around the well collar.

Placement of Gravel Fill. Types of impacts to soils from placement of gravel fill would be similar to those in Alternative A. Construction of CPFs and associated satellite pads, staging areas, roads, and airstrips would result in the loss of soil productivity in the areas of gravel placement. However, more area could be covered with gravel due to the greater expected number of facilities needed. Under Alternative C, 7 fields would be developed, resulting in approximately 3,850 acres of soil productivity lost by gravel placement (Table 4.2-G).

Construction of gravel pads, roads, staging areas, and airstrips could alter the moisture regime of tundra near the structure by changing natural drainage patterns and areas where snow accumulates. Snowdrifts caused by gravel structures would increase the wintertime soil surface temperature and increase thaw depth in soils near the structures. These impacts would be exacerbated by dust deposition and by the formation of impoundments. These factors could combine to warm the soil, deepen thaw, and cause thermokarst adjacent to roads and other gravel structures (NRC 2003). In flat, thaw-lake plains on the North Slope, gravel construction can be anticipated to result in upslope water impoundment and thermokarst erosion equivalent to the area directly covered by gravel (Walker et. al. 1987). In this analysis, approximately 3,850 acres could be covered by gravel under Alternative C. Therefore, the total area of soils impacted by gravel fill under Alternative C is estimated at approximately 7,700 (2 x 3,850) acres. This area is somewhat greater than in the other alternatives.

Material Sites. In this analysis, the likelihood of new gravel sites within the planning area would be somewhat greater under Alternative C than under the other alternatives (Table 4.2-

G). Gravel required for development in the planning area could be mined from existing sites east of the planning area or could be extracted from new sites developed within the planning area. Investigations to identify gravel sources in the planning area have not been conducted, but presumably would be initiated if discoveries of recoverable oil or gas were made. It is possible that 16 gravel mine sites would be necessary, resulting in a total of 800 acres impacted, depending on the actual number of sites required. Excavation of the gravel mine and stockpiling of overburden would remove soil and impact soil productivity at these sites.

Pipelines. Under Alternative C, given the potentially greater number of fields developed, impacts from pipeline construction would be greater than those described for the other alternatives. Pipelines on the North Slope are typically built on VSMs with a diameter of 12 inches and a spacing of 150 VSMs/mile. Under Alternative C, approximately 502 miles of pipeline would be required resulting in short term disturbance to soils of approximately 1,523 acres and a long term impact at VSM sites to a total of approximately 2 acres (Table 4.2-G).

The extent of impacts associated with buried pipelines could also be greater under Alternative C, given the potentially greater number of fields developed. However, it is not possible to quantify how many more buried pipeline segments would be required under Alternative C than under the other alternatives. In areas where pipelines were buried, construction of a trench would impact soil and temporary storage of overburden in adjacent areas would alter soil where temporary storage of the overburden occurred. The zone of impact would be approximately 12 feet wide for the length of the buried segment, and the total area of impact would be 1.5 acres per pipeline mile. Because pipeline burial under tundra has been the exception on the North Slope rather than the norm, it is expected that this activity would disturb only a small amount of area in the planning area.

Effects of Oil and Gas Development on Permafrost

Types of impacts to permafrost from oil and gas development would be the same as those described in Alternative A. Under alternative C, more surface disturbance is expected from oil and gas activities as compared to the other alternatives (Table 4.2-G). Therefore, there would be more area of permafrost potentially affected.

Effects of Abandonment and Rehabilitation

Types of impacts from abandonment and rehabilitation would be the same as those described in Alternative A. Under alternative C, it is expected that more structures would be constructed for oil and gas activities as compared to the other alternatives (Table 4.2-G). Therefore, the amount of rehabilitation required, and impacts to soils from abandonment and rehabilitation, would be greater than under the other alternatives.

Effects of Spills

Under Alternative C, types of impacts to soils from spills would be the same as those described in Alternative A. However, potential impacts to soils from oil spills would be greater than the other alternatives as the estimated number of large and small spills is slightly greater (see **section 4.2.2, *Oil Spills***).

Summer Tundra Travel

Under Alternatives B, C, and D some summer tundra travel would be permitted under specific circumstances. Although travel off of gravel pads is easiest in winter and generally environmentally preferable at that time, some vehicle travel off of pads does occur in North Slope oil fields during the summer to accomplish specific tasks. The State of Alaska has approved some low-ground-pressure vehicles for summer tundra travel after July 15. Similar summer tundra travel may be anticipated to be part of oil production in Northeast NPR-A.

Summer vehicle tundra travel is commonly associated with spill prevention and preparedness measures required in spill prevention plans. Each summer season, low-ground-pressure vehicles might be used to transport and place booms across streams downstream from pipelines. These booms are left in place through the summer to capture any oil that might spill from a pipeline and then would be retrieved, again probably using low-ground-pressure vehicles, before freeze-up. Pipeline inspections may also entail summer vehicle travel on the tundra. Finally, periodically spill response training may occur along and downstream from pipelines in summer.

As a rule, summer tundra travel would not be permitted under Alternative A. Therefore, given the potentially greater number of fields developed and allowance of summer tundra travel under certain circumstances, impacts from summer tundra travel under Alternative C could be greater than in the other alternatives. Short-term, minor impacts to soils are expected from limited summer tundra travel using low ground pressure vehicles. However, ROP L-1 is designed to regulate and monitor summer travel and minimize impacts to soils and vegetation. Summer travel would only be permitted on a case-by-case basis if the applicant can demonstrate that the proposed use would have no more than minimal impacts to soils and vegetation.

Commercial Gas Development

Under Alternative C, the types of impacts on soils that natural gas development and production would cause would be the same as those described for Alternatives A and B, but the extent of such impacts may be larger. If a gas pipeline is buried, there would be additional acreage of soils disrupted with reduced soil productivity. The estimated 182-mile-long gas pipeline would impact about 90 acres of soils directly through excavation of a 4-foot-wide trench and, potentially, 240 acres through compaction, thermokarst, and other indirect effects. In addition, ice roads that may be associated with placement of the gas pipeline would have localized, short-term impacts on soils, which would usually be limited to compression of the tundra under the ice roads and damage to the tops of tussocks in dryer soils.

Soils thus disturbed in the ice-rich northern part of the planning area are more likely to experience thermal degradation and subsidence as a result. In this case, the soils would not be lost completely, but soil horizons as well as the thermal regime would be altered. Melting of ice in the soils would result and the filled area, normally mounded immediately after fill, would level over time as melt water migrates. Ponding, and potentially soil erosion, could occur if the trench surface subsides below the grade of the surrounding terrain over time. These impacts would be dramatically reduced if gas pipelines were put on VSMs.

4.5.3.3 Effectiveness of Stipulations and Required Operating Procedures

Under Alternative C, the lease stipulations and ROPs that protect soil resources would be the same as those discussed for Alternative B. Many of the lease stipulations and ROPs, as

discussed under Alternative B, would directly or indirectly limit potential impacts to soils in the planning area. These protections would be similar to those provided for Alternative A.

4.1.1.4 Conclusion

Under Alternative C, the amount of soil area impacted from oil and gas exploration and development would potentially exceed those of the other alternatives as additional high-potential oil and gas areas would be available for leasing. See Table 4.2-G for a comparison of estimated total surface area disturbed by alternative. Numerous technological advancements have been made during the decades of operations on the North Slope that have allowed current development activities to proceed with less environmental impact than previous operations (NRC 2003). However, some short-term disturbance and permanent long-term impacts to soils are inevitable.

Impacts to soil from management actions under Alternative C would involve short-term disturbance over fairly large areas and long-term disturbance of relatively small areas. However, even though impacts in Alternative C cover more of the planning area than the other alternatives (Table 4.2-G), all areas of soil disturbance would be relatively small as a percentage of the entire planning area (see below). The duration of these impacts could range from one year or less for minor disturbance of soil and vegetation to decades if the soil was destroyed or permafrost thawing was extensive.

Under Alternative C, impacts to soils from activities other than oil and gas development would be similar to those of the other alternatives and would include minor impacts from activities such as aircraft landings, archaeological or paleontological excavations, camps, and overland moves. Recovery would vary from 1 year for minor disturbance of soil and vegetation to one or more decades in those areas where soil was excavated or permafrost thawing was extensive.

Impacts from seismic activities would be the same for all alternatives. Short-term impacts could occur on approximately 8,100 acres (0.18 % of the planning area) of soil from 2-D seismic surveys and 100,000 acres (2.2 % of the planning area) of soil from 3-D surveys during a 25-year period (Table 4.2-F).

Under Alternative C, approximately 1,500 acres could be impacted short-term by pipeline construction. Short-term impacts would also occur from temporary ice roads, ice pads, and ice runways. For Alternative C, it is estimated that a total of 7,200 miles of ice road would be constructed during the life of the plan for exploration and development impacting approximately 22,000 acres (Table 4.2-G). In addition, approximately 1,260 acres could be impacted by ice pads for exploration and delineation wells and 40 miles of ice runway would be constructed impacting approximately 440 acres. In total, potential short-term impacts to soils under Alternative C from exploration (excluding seismic activities) and development would be approximately 25,000 acres or 0.55% of the planning area. This is greater than the other alternatives due to more surface disturbance expected from oil and gas activity.

Oil and gas development and operation would affect soils by compacting and damaging soils under gravel pads, roads, and airstrips; and by excavating material sites and constructing VSMs. These impacts would be long-term. Long-term impacts would occur on an estimated 7,700 acres of soil from gravel structures for field and staging area development, and 800 acres from gravel extraction activities (Table 4.2-G). Therefore, these activities could result in long-term impacts to approximately 8,500 (7,700 + 800) acres or 0.18% of the planning area. This is approximately 2,500 more acres than under Alternative A and 1,700 more acres that

Alternative B. The placement of pipelines underground could disturb an additional 1.5 acres per buried pipeline mile.

Impacts associated with oil spills, the majority of which would be cleaned up immediately, could aversely affect soil resources for a few years to several decades depending on the quantity, location, and season of the spill. The potential for impacts from oil spills would be greater under Alternative C than under the other alternatives since more area would be available for development in an area with relatively high oil and gas potential, and the estimated number of large and small spills is slightly greater than in the other alternatives (see **section 4.2.2, Oil Spills**).

Under Alternatives B, C, and D some summer tundra travel would be permitted under specific circumstances. Short-term, minor impacts are expected from limited summer tundra travel using low ground pressure vehicles. However, ROP L-1 is designed to regulate and monitor summer travel and minimize impacts to soils and vegetation. Summer travel would only be permitted on a case-by-case basis if the applicant can demonstrate that the proposed use would have no more than minimal impacts to soils and vegetation.

Impacts to soil resources from non-oil and gas activities, and from oil and gas activities, would likely be additive in most cases, except in those areas where the two types of activities overlapped. In these areas the total actual impact could be less than the sum of both impacts because some of the activity would occur on areas already impacted. Impacts to soil resources from exploration and development activities would also be additive, except where development activities occurred in areas previously disturbed during exploration. In areas where two or more activities occurred, overall impacts would reflect those impacts associated with the first activity and any new impacts associated with later activities.

Although all soil map units identified on Map 3-5 could be impacted during oil and gas exploration and development, soil associated with map units IQ6 and IQ21 (see **section 3.2.7, *Soil Resources*** and Map 3-5) would likely be most affected since they are located in the area having high oil potential. Lease stipulations and ROPs developed for Alternatives B and C would provide protection similar to or slightly greater than lease stipulations in Alternative A.

4.5.4 Water Resources

4.5.4-a Surface Water and Groundwater Resources

An additional 211,000, 213,000 and 600,000 acres would be available for oil and gas leasing under this alternative as compared to the Alternative D, Alternative B, and Alternative A, respectively. Thus, impacts to water resources could be greater under this alternative if development occurs in areas closed to leasing under the other alternatives, or more areas are explored and developed under this alternative than under the other alternatives.

4.5.4-a.1 Activities Not Associated With Oil and Gas Exploration and Development

Activities not related to oil and gas exploration and development that could occur in the planning area under Alternative C include aircraft use, watercraft use, collection and excavation for scientific research, hunting camps, recreational use of the area, and use of the

area by local natives for subsistence. These activities would be expected to occur at the same frequency and intensity, or slightly greater, compared to other alternatives. All of these activities have the potential to impact water resources. However, all of these activities have also been ongoing for many years with minimal impact to water resources.

4.5.4-a.2 Oil and Gas Exploration and Development Activities

The effects of oil and gas exploration and development under this alternative would be greater than all other Alternatives since the entire planning area would be open for leasing. The amount of acreage in the planning area potentially affected by oil and gas activities would be the largest under this alternative, and would be considerably larger than under Alternative A (approximately 600,000 more acres). Thus, the potential for impacts to water resources as a result of oil and gas activities would be the greatest under Alternative C. Drilling on and near Teshekpuk Lake greatly increases the risk for an oil spill in this fish-bearing lake. Therefore, Alternative C is less protective of water resources than all other Alternatives, particularly for Teshekpuk Lake.

Effects of Exploration and Development

Seismic activities and overland travel. Effects to water resources from seismic surveys would be the same as described for Alternative A unless seismic boats are used in Teshekpuk lake Under all of the alternatives, it is projected that three 2-D and two 3-D surveys would be done to fill in gaps in existing surveys and amount to the same level of impacts.

Ice Road and Pad Construction. Types of impacts from ice road, pad, and airstrip construction would be the same as described under Alternative A. However, under Alternative C the potential impacts of ice roads on water resources would be greater than under other alternatives because more of the planning area would be open for leasing, and more ice pad and road construction would be likely to occur. For Alternative C, it is estimated that a total of 7,182 miles of ice road (21,763 acres), 210 exploration and delineation well ice pads (1,260 acres), and 40 ice airstrips (440 acres) would be constructed during the estimated exploration and development scenario resulting in a total of 23,463 acres of short-term surface disturbance. Impacts to the tundra under this alternative should be minimal and limited mainly to the spring when the ice roads and pads would melt and add somewhat saline water to the shallow tundra pools. This impact would likely be temporary in nature since these ponds will be recharged by local snowmelt and runoff.

Ice Road/Pad Water Use. Types of impacts from ice road/pad water use would be the same as described under Alternative A. Approximately 50 miles of ice road would be needed each year under all alternatives resulting in the use of approximately 75 million gallons (MG) of water per year (50 miles x 1.5 MG/mile). However, it is estimated that more water would be used over the life of the Plan than under Alternative A and B since more high oil and gas potential area would be open for exploration and development and ice roads, pads, and airstrips constructed.

Drilling & Camp Water Use. Types of impacts from drilling water use would be the same as described under Alternative A. Under Alternative C, water withdrawal from lakes for drilling water would be governed by the same lease stipulations and ROPs as those for ice roads and pads. Therefore, it is expected that impacts to surface water resources would be minor because of lease stipulations governing the amount of drawdown allowed in the lakes, and which lakes could be used as water sources. Because more of the planning area would be open to leasing under Alternative C, more lakes could potentially be impacted by water withdrawal during the

winter months than under other alternatives. Lease Stipulations K-1 (Rivers Area) and K-2 (Deep Water Lakes) would be protective of water resources in streams and fish-bearing lakes, but given the greater number of lakes, Alternative C could potentially have more impact on lakes, especially non-fish bearing lakes, than other alternatives.

Snow Compaction. Types of impacts from snow compaction would be the same as those described under Alternative A. Because a greater number of lakes could potentially be affected by snow compaction under Alternative C, impacts to more lakes could occur than under other alternatives. Under all alternatives, snow compaction would be prohibited on fish-bearing lakes, except at ice road crossings. Therefore, this alternative would be protective of lakes and streams. No impacts to ice thickness on fish-bearing lakes are expected as a result of oil and gas exploration and development activities. However, lakes without fish could be subject to impacts due to snow compaction if this activity were authorized by the AO.

Drainage Disruption. Types of impacts from disruption of drainage patterns would be the same as those described under Alternative A. Under Alternative C, drainages would be protected by ROPs and lease stipulations. These ROPs and lease stipulations require setbacks from specified rivers, require bridges rather than culverts for crossing major rivers, and require that culverts used for small drainages have ample capacity to handle the flow of the drainage during spring breakup to avoid ice jams. Thus, this alternative would minimize impacts to drainages from construction of permanent and temporary facilities related to crossing the drainage. Overall, impacts to drainages should be minor under this alternative as a result of these lease stipulations.

However, because a greater portion of the planning area would be open to oil and gas leasing under Alternative C, there could potentially be more disruption of drainages than under the other alternatives. However, if the lease stipulations and ROPs listed for this alternative are followed, this potential increase in impacts should be minor.

Channel Erosion and Sedimentation. Types of impacts from channel erosion and sedimentation would be the same as those described under Alternative A. Lease stipulations and ROPs developed for Alternative C to mitigate for disturbances to drainages, streams, and rivers by exploration and production activities would be similar to those developed for Alternative B. These lease stipulations and ROPs regulate bridges, culverts, winter crossings, removal of ice bridges, and any temporary facilities constructed near rivers. They also include setbacks for specified rivers. These ROPs and lease stipulations should mitigate impacts to stream channels. However, because more of the planning area would be open to oil and gas leasing under Alternative C, there would potentially be more channel erosion and sedimentation under this alternative than under all other Alternatives. If the lease stipulations and ROPs developed for this alternative were followed, this potential increased impact to stream channels should be minor.

Gravel Removal. Types of impacts to water resources from gravel sites would be the same as those described under Alternative A. Under Alternative C, gravel mining sites would not be permitted in the active floodplain of a river, stream, or lake unless authorized by the AO. Gravel mining sites would also to be kept to a minimum in the planning area, and, where possible, be designed so that fish and wildlife could use them after mining was completed. These measures would protect streams, rivers, and lakes and keep impacts to floodplains to a minimum. However, because more of the planning area would be open to oil and gas leasing under Alternative C, there would potentially be more gravel removal under this alternative than under all other Alternatives. It is possible that 16 gravel mine sites could be necessary,

impacting a total of 800 acres (see **section 4.2.1.2, Table 4.2-G**). Lease stipulations and ROPs developed for Alternative C would be effective in reducing impacts to streams and lakes from gravel removal.

Pipelines. Types of impacts from pipeline construction and operation would be the same as those described under Alternative A. However, under Alternative C more miles of pipeline could be constructed since more area of high oil and gas potential is open to development than under other alternatives. Under Alternative C, 502 miles of pipeline would be required resulting in short-term disturbance to soils of approximately 1,520 acres (See **section 4.2.1.2**, Table 4.2-G). However, ROPs and lease stipulations for Alternative C, such as construction during the winter, would prevent or minimize impacts to water resources.

Commercial Gas Development

If commercial gas is developed on the North Slope, impacts to water resources from gas development in the planning area would be similar to those from oil development but slightly larger than those of the other alternatives. Among the alternatives considered in this Supplemental IAP/EIS, Alternative C, which is estimated to have approximately 12% more gas pipeline than the other alternatives, is likely to have the greatest impacts on water resources. In addition, like Alternatives B and D, Alternative C would make more lands available in the ice-rich areas especially susceptible to thermokarst, subsidence and erosion, and thus could have greater impacts from burying a gas pipeline. Potential impacts during burial of a gas pipeline could include temporary impoundments, diversions, and sedimentation. Buried gas lines also have potential thermokarst, subsidence, and erosion problems that could persist beyond the construction phase. If all work on the pipelines is done during winter, these impacts would be greatly reduced. Placement of the gas pipeline on VSMs would also obviate these impacts associated with pipeline burial.

4.5.4-b Surface Water and Groundwater Quality

4.5.4-b.1 Activities Not Associated With Oil and Gas Exploration and Development

Impacts under Alternative C would be expected to be similar to those described under Alternative A. The only types of non-oil and gas activities in the planning area that are likely to affect freshwater quality would be ongoing subsistence and recreational activities, primarily along rivers and lakes in the ACP, and use of lakes by floatplanes and watercraft. These activities have been ongoing for sometime, and impacts to freshwater quality appear to have been negligible.

4.5.4-b.2 Oil and Gas Exploration and Development Activities

Types of impacts from oil and gas exploration activities under Alternative C would be similar to those described under Alternative A. The main difference between these alternatives pertaining to water resources is that Alternative C opens the entire planning area to exploration and development, including the area within and near Teshekpuk Lake. This greatly increases the likelihood of exploration or development activities impacting water resources and quality in the lake and areas to the north.

Potential surface water quality impacts for oil and gas exploration and development fall into three general source categories: accidental release of fuels and other substances (including oil

spills), which could occur during both the construction and operation periods; reductions in dissolved oxygen and changes in ion concentrations in lakes used for water supply, which would occur mainly during construction but could also happen during operations; and increases in terrestrial erosion and sedimentation causing higher turbidity and suspended solids concentrations, which could occur during both the construction and operational periods. The following analysis is based on **section 4.2.1.2, *Oil and Gas Exploration and Development Activities*.** See that section for a description of how estimated areas of disturbance were calculated for each alternative.

Effects of Exploration

Exploration activities that could affect water quality within the planning area under all alternatives would be seismic surveys; ice-road and ice-pad construction; and drilling-fluid storage and disposal. Oil spills would predominantly be attributable to development activities; therefore, spills will be discussed under the analysis of development impacts.

Seismic Activities and Overland Travel. Effects to water quality from seismic surveys would be the same as those described for Alternative A unless seismic boats are used in Teshekpuk Lake) Under all of the alternatives, it is projected that three 2-D and two 3-D surveys would be done to fill in gaps in existing surveys.

Ice Road/Pad Water Use. Types of impacts from ice road/pad water use are the same as those described in Alternative A. Water use is expected to be greater than under the other alternatives. For Alternative C, it is estimated that a total of 7,200 miles of ice road would be constructed during the life of the plan impacting approximately 22,000 acres (See **section 4.2.1.2,** Table 4.2-G). In addition, approximately 40 miles of ice runway would be constructed impacting approximately 440 acres. However, as discussed under Alternative A, studies in other areas of the North Slope have shown that water withdrawal from lakes for ice roads and pads has not measurably affected long-term water quality (Baker, 2002; Hinzman, 2006).

Drilling Water Use and Drilling Fluids. Types of impacts from drilling water use would be the same as those described in Alternative A. However, more exploration wells would likely be needed under Alternative C. Under this alternative, it is assumed 210 exploration and delineation wells would be drilled from ice pads in the planning area. The preferred means of disposing of drilling wastes, including muds and cuttings, would be reinjection into wells, which would not cause impacts to surface water quality. Mud pits and surface discharge of exploration drilling muds and cuttings would be prohibited. Under this scenario, there likely would be a negligible impact to water quality from drilling fluids used in exploration.

Effects of Development

Development activities that could affect water quality in the planning area include spills; excavation of material sites; stream crossings; summer tundra travel; and construction of gravel roads, pads, and airstrips.

Spills. The greatest risk to water quality from oil and gas activity in the planning area is the potential for spills, with impacts dependent upon the size, season and nature of the spill. Effects of spills would be similar to those described in Alternative A. Under Alternative C, however, the entire planning area would be open to exploration and development. Therefore, potential impacts to water quality from oil spills could be larger than in other alternatives as the estimated number of large and small spills is greater (see **section 4.2.2, Oil Spills**). In

addition, Alternative C allows for drilling within and near Teshekpuk Lake. This greatly increases the likelihood of a spill impacting water resources and quality in this lake.

As noted in the 1998 Northeast IAP/EIS (USDOI BLM and MMS 1998), a small spill (less than 4 bbls) reaching Teshekpuk Lake would likely have a minimal effect on water quality. Dissolved oxygen levels could be affected locally. Direct toxicity would be minimal because of the much greater dilution volume in Teshekpuk Lake than in the small ponds and lakes discussed earlier, and because of the relatively unrestricted movement of the slick and underlying water. The spreading of the spill over about 60 acres (0.03% of the lake surface) would have an adverse effect on water quality in this area of the lake. This effect would persist for a few weeks, until the slick was either cleaned up or the oil stranded on the shoreline. Similar effects would be expected if an oil spill were to reach any of the lakes in the planning area. The effects on water quality if a large spill was released directly to surface water could be large and extensive, and the magnitude of the effects would depend on the speed of cleanup response teams and the local conditions affecting oil dispersion. The probability of this type of spill occurring is very small. Under Alternative C, more construction of gravel structures, gravel roads, ice roads and pads, and more drilling in environmentally sensitive areas, would be expected. Thus, potential for impacts to surface water quality would be greater under this alternative than under other alternatives.

Gravel Structures. Types of impacts to water quality from construction of CPFs, gravel roads, pads, and airstrips, and staging areas would be similar to those described in Alternative A. However, under this alternative, it is estimated that 7 fields would be developed, resulting in direct impacts of approximately 3,850 acres impacted by gravel placement. It is anticipated that gravel construction would result in indirect impacts of upslope water impoundment and thermokarst erosion equivalent to at least the same area as that directly covered by gravel, or about 3,850 acres for the development assumptions made under this alternative. This is greater than the other alternatives and would increase the potential for thermokarst erosion to result in water features with high turbidity and suspended-sediment concentrations.

Gravel Removal. Types of impacts from development of gravel sites would be the same as those described in Alternative A. Under Alternative C it is possible that 16 gravel mine sites would be necessary, resulting in a total of 800 acres impacted, depending on the actual number of sites required. This is more area affected than estimated for the other alternatives. Therefore, the potential is greater for impacting water quality locally by an increase in thermokarst and erosion at gravel extraction sites. ROP E-5 is designed to minimize the development footprint and would also minimize the amount of gravel and, therefore, gravel sites. ROP E-8 is designed to minimize the impact of mineral materials mining activities on air, land, water, fish, and wildlife resources. It would require that sites are located outside the active floodplain and would encourage their use for reservoirs and sites for enhancing fish and wildlife habitat. These ROPs would minimize effects to water quality from material sites.

Summer tundra travel. Given the potentially greater number of fields developed, impacts from summer tundra travel under Alternative C could also be greater than Alternatives B and D. Short-term, minor impacts are expected from limited summer tundra travel using low ground pressure vehicles. ROP L-1 is designed to regulate and monitor summer travel. Summer travel would be permitted on a case-by-case basis if the applicant can demonstrate that the proposed use would have no more than short-term impacts to soils; vegetation; and, therefore, water quality.

Stream Crossings. Types of impacts to water quality from stream crossings would be the same as those described in Alternative A. Under Alternative C, it is estimated that more roads (see **section 4.2.1.2,** Table 4.2-G) and, therefore, steam crossings could be necessary to reach additional areas of high oil and gas potential. The potential for constricting flows and creating increased stream velocities, ice jams, ice impacts, scour, and streambank erosion would be greater. However, Lease Stipulations 42, 43, and 44 provide guidance on the use of bridges and culverts that would help ensure natural drainage pattern are maintained.

Pipelines. Types of impacts from pipeline construction and operation would be the same as those described in Alternative A. Under Alternative C, given the potentially greater number of fields developed, impacts from pipeline construction would be greater than those described for all other Alternatives. Under Alternative C, 502 miles of pipeline would be required resulting in short-term disturbance to soils of approximately 1,520 acres and a long-term impact at VSM sites of approximately two acres (see **section 4.2.1.2,** Table 4.2-G).

The extent of impacts associated with buried pipeline could also be greater under Alternative C given the potentially greater number of fields developed. Because pipeline burial under tundra has been the exception on the North Slope rather than the norm, it is expected that this activity would disturb only a small amount of area in the planning area.

Effects of Abandonment and Rehabilitation

Types of effects from abandonment and rehabilitation would be the same as those described in Alternative A. Under Alternative C, given the potentially greater number of fields developed, impacts from abandonment and rehabilitation would be greater than those described for other alternatives. See **section 4.2.1.2,** Table 4.2-G for a comparison of areas impacted by infrastructure that would need to be rehabilitated. Lease Stipulation G-1 could require removal and reclamation of the developed site(s) upon field abandonment, which would eventually result in restoration of the natural drainage.

Commercial Gas Development

If commercial gas is developed on the North Slope, impacts to water quality from gas development in the planning area would be similar to those from oil development, though would not include impacts from oil spills. Alternative C could result in slightly larger water quality impacts than those of the other alternatives. Among the alternatives considered in this Supplemental IAP/EIS, Alternative C, which is estimated to have approximately 12% more gas pipeline than the other alternatives, is likely to have the greatest impacts on water resources. In addition, like Alternatives B and D, Alternative C would make more lands available in the ice-rich areas especially susceptible to thermokarst, subsidence and erosion, and thus could have greater impacts from burying a gas pipeline. Potential impacts during burial of a gas pipeline could include temporary impoundments, diversions, and sedimentation. Buried gas lines also have potential thermokarst, subsidence, and erosion problems that could persist beyond the construction phase. If all work on the pipelines is done during winter, these impacts would be greatly reduced. Placement of the gas pipeline on VSMs would also obviate these impacts associated with pipeline burial.

4.5.4.3 Effectiveness of Stipulations and Required Operating Procedures

Under Alternative C, the lease stipulations and ROPs listed in Table 2-2 would potentially mitigate impacts to water resources because they would require setbacks from rivers and fish-

bearing lakes for oil and gas activities, place limits on the withdrawal of water from fish-bearing lakes, and regulate the construction of gravel roads, ice roads and pads, and pipelines. Also, oil spill prevention and response procedures would be required, as would oil spill clean-up procedures. Refueling would be regulated and thereby kept away from rivers and lakes, particularly fish-bearing lakes. The required snowpack would be present on the tundra before seismic equipment would be allowed to make overland moves during winter. Drilling would not be allowed in streams, rivers, or fish-bearing lakes.

Several lease stipulations and ROPs would protect water quality under Alternative C. Required Operating Procedures A-1 through A-7 would regulate garbage, wastewater, drilling wastes, fuel and chemical storage, fuel handling, and spill prevention and clean-up plans. Required Operating Procedure B-1 would prohibit water withdrawal from rivers during winter and ROP B-2 would regulate amounts of winter water withdrawals from lakes. Required Operating Procedures C-2 through C-4 would regulate overland moves, seismic work, ice-road construction, and other heavy equipment travel during the winter to limit impacts to water resources. Lease Stipulation D-1 would limit exploratory drilling in shallow lakes, streams, and floodplains, but would allow exceptions if there was no feasible or prudent alternative.

Required Operating Procedures and Lease Stipulations E-2, E-3, E-6, and E-8 would limit certain facility, structure, and gravel mine site design and construction impacts near lakes and rivers, but would allow exceptions if there was no feasible or prudent alternative. ROP E-5 is designed to minimize the development footprint and would also minimize the amount of gravel and, therefore, gravel sites. ROP E-8 is designed to minimize the impact of mineral materials mining activities on air, land, water, fish, and wildlife resources. It would require that sites are located outside the active floodplain and would encourage their use for reservoirs and sites for enhancing fish and wildlife habitat. These ROPs would minimize effects to water quality from material sites. Lease Stipulation G-1 could require removal and reclamation of the developed site(s) upon field abandonment, which would eventually result in restoration of the natural drainage. Lease Stipulation K-1 would be equally effective as Alternative A Lease Stipulation 39 in protecting aquatic, floodplain, and riparian areas adjacent to rivers identified as having critical aquatic and riparian habitat, except in certain large rivers. Lease Stipulation K-2 would be equally effective as Alternative A Lease Stipulation 39 in protecting aquatic and riparian areas adjacent to deepwater lakes, but would allow exceptions if there were no feasible or prudent alternatives.

4.5.4.4 Conclusion

Under all alternatives, this analysis shows that impacts to water resources from non-oil and gas activities would be minor. Most impacts from and oil and gas exploration would also be minor and short-term. Short-term impacts include water withdrawals from lakes for ice roads and pads. Seismic activities could result in thermokarst and erosion on approximately 153 acres during a 25-year period under all alternatives.

Under Alternative C, the amount of area impacted from oil and gas exploration and development would potentially exceed those of the other alternatives as additional high-potential oil and gas areas would be available for leasing. Therefore, potential impacts to water resources from development infrastructure such as CPFs, roads, pads, runways, pipelines, pump stations, and staging bases, would also be greater (see **section 4.2.1.2,** Table 4.2-G, for a comparison of infrastructure by alternative). Long-term impacts from development of infrastructure could have direct impacts of approximately 3,850 acres and indirect impacts of approximately 3,850 acres under Alternative C. Impacts could include disturbance of stream

banks or shorelines and subsequent thawing of permafrost (thermokarst); and blockages of natural channels and floodways which would disrupt drainage patterns. Excavation of material sites would also result in a loss of approximately 800 acres. Total long-term impacts would total 8,500 acres.

Under Alternative C, it is estimated that more roads and, therefore, steam crossings could be necessary to reach areas of high oil and gas potential. The potential for constricting flows and creating increased stream velocities, ice jams, ice impacts, scour, and streambank erosion would be greater. However, Lease Stipulations 42, 43, and 44 provide guidance on the use of bridges and culverts that would help ensure natural drainage pattern are maintained.

The greatest risk to water quality from oil and gas activity in the planning area is the potential for spills. Under Alternative C, the estimated number and volume of large and small spills would be greater than those estimated for other alternatives since additional high oil potential areas would be available for development. In addition, there is greater potential for a spill from oil and gas activities to affect water quality in Teshekpuk Lake as the entire planning area, including the Lake, would be available for oil and gas leasing.

Impacts to water resources from non-oil and gas activities, and from oil and gas activities, would likely be additive, except in those areas where the two types of activities overlapped. Impacts to water sources from exploration and development activities would also be additive, except where development activities occurred in areas previously disturbed during exploration. In areas where two or more activities occurred, overall impacts would reflect those impacts associated with the first activity and any new impacts associated with later activities.

Numerous technological advancements have been made during the decades of operations on the North Slope that have allowed current development activities to proceed with less environmental impact than previous operations (NRC 2003). While any surface-disturbing activity could affect water resources, the lease stipulations and ROPs under Alternative C would help mitigate impacts to these resources.

4.5.5 Vegetation

4.5.5.1 Activities Not Associated With Oil and Gas Exploration and Development

Under Alternative C, impacts associated with non-oil and gas activities would be similar to those described under Alternatives A and B. These activities could occur throughout the planning area, and at more or less the same frequency and intensity as under the other alternatives, despite the increased availability of land for oil and gas leasing. There could be some increased use of off-road vehicles in the planning area due to an increase in the amount of roads associated with development. However, additional impacts to vegetation from this increase would likely be small.

4.5.5.2 Oil and Gas Exploration and Development Activities

Effects of Disturbances

Exploration

Under Alternative C, types of impacts to vegetation from activities associated with oil and gas exploration would be similar to those that occur under other alternatives. There would be a greater number of exploration and delineation wells drilled, which would increase the impacts of well collar construction and the number and impacts of both ice pads and ice roads.

Under Alternative C, the same scenario for seismic exploration is assumed as for the other alternatives. Short-term vegetation disturbance from 2-D and 3-D operations combined would total a maximum of 107,996 acres (2.3% of the 4.6 million acre planning area). Long-term disturbance is estimated to total 153 acres.

During the life of the plan, it is assumed that 120 exploration wells and 90 delineation wells, or a total of 210 wells, would be drilled from ice pads in the planning area under Alternative C. At six acres per pad, these would impact 1,260 acres of tundra, spread out over 50 years (39% more than Alternative A and 24% more than Alternative B). Assuming that 4% (nine) of these would also involve an over-summer ice pad, an additional 54 acres of vegetation would be affected by ice pads (29% more than Alternative B).

Under Alternative C, ice road construction would also increase in terms of total miles constructed because of an increase to seven in number of total fields discovered and an increase from 162 to 182 miles of sales-oil pipeline. The total short term disturbance from ice roads over 50 years would be 21,763 acres, about 39% more than for Alternative A and 17% more than for Alternative B. Since vegetation recovery from ice road impacts is expected within a few years (Yokel et al. in press), long-term disturbance from ice roads would be negligible. Although some evidence of crushed tussocks may still be apparent, new growth would preclude any exposed soils.

Ice airstrips are also used during exploratory drilling, and under Alternative C it is assumed that 40 ice airstrips would be constructed covering 11 acres each for a total of 440 acres (100% more than Alternative A and 33% more than Alternative B). These airstrips are commonly built on the grounded ice of large lakes, but if they were built over tundra they would result in impacts similar to ice roads.

The construction of well cellars during exploration requires the digging of a hole that destroys vegetation on approximately 16 square feet (0.0004 acres) of ground. Thermokarst associated with the disruption of thermal regime in the surrounding soil may also change the vegetation type around the well cellar to a wetter vegetation type. These impacts could result in 0.08 acres of vegetation being destroyed under Alternative C (39% more than Alternative A and 24% more than Alternative B).

Development

During oil and gas development and production, various activities could cause impacts to vegetation in the planning area. These activities include construction and use of gravel pads, staging areas, roads, airstrips, and pipelines, excavation of material sites, and construction of ice roads and ice pads. Ice roads and pads are covered above.

Placement of Gravel Fill. Construction of CPFs and associated satellite pads, roads, staging areas, and airstrips would result in the destruction of vegetation in the areas of gravel placement. Under this alternative, seven CPFs and associated satellite pads, roads and airstrips, seven pump stations, and four staging bases would be developed, resulting in 3,847 acres of vegetation destroyed by gravel placement (42% more than under Alternative A and 26% more than under Alternative B).

The increased construction and use of facilities under Alternative C would result in a larger area impacted by dust than under the other alternatives. Assuming a total of 320 miles of in-field gravel roads and 7 miles of airstrips, there is a potential for a total perimeter of 654 miles. Within 30 feet of gravel fill, up to 2,378 acres of vegetation could be subject to smothering by dust and gravel, and another 9,513 acres could be affected by a dust shadow.

Construction of gravel pads, roads, and airstrips could alter the moisture regime of tundra near the structure by changing natural drainage patterns and areas where snow accumulates. Snowdrifts caused by gravel structures increase the wintertime soil surface temperature and increase thaw depth in soils near the structures. These impacts are exacerbated by dust deposition (described above) and by the formation of impoundments (described below). These factors could combine to warm the soil, deepen thaw, and produce thermokarst adjacent to roads and other gravel structures (NRC 2003). Additionally, these changes could alter the species composition of the plant community near gravel structures. In general, most changes in the plant community around gravel structures would occur within 164 feet of the structure. If all effects were to occur within this zone, approximately 13,001 acres would be impacted under Alternative C (39% more than under Alternative A and 28% more than under Alternative B). Note that this area includes the 11,891 acres affected by dust above, and is not in addition to it.

Material Sites. Gravel required for development in the planning area could be mined from existing sites east of the planning area or could be extracted from new sites developed within the planning area. Investigations to identify gravel sources in the planning area have not been conducted, but presumably would be initiated if discoveries of recoverable oil or gas were made. Under Alternative C it is assumed that 16 material sites, each affecting 50 acres, would be needed. This would cover a total area of 800 acres (45% more than under Alternative A and 23% more than under Alternative B). Excavation of gravel and stockpiling of overburden would destroy vegetation at these sites.

Pipelines. Under Alternative C, impacts from oil pipeline construction would be similar in nature to those described for the other alternatives. The total area disturbed by each VSM would be about 14 square feet. Overall, 0.03 acres of vegetation would be disturbed by VSMs per pipeline mile. Under Alternative C, 320 miles of gathering lines and 182 miles of sales-oil pipelines would disturb 15 acres of vegetation through VSM placement (about 25% more than under Alternative A and 20% more than under Alternative B). In addition, if commercial gas development occurred in the planning area, the impacts of gas pipelines would likely be the similar to, but slightly larger than that described for the other alternatives because it is anticipated that 90 acres of vegetation would be destroyed by digging a four-foot-wide trench and an additional 240 acres impacted along the route through compaction by machinery or by stockpiling overburden.

Summer Tundra Travel. On a case-by-case basis, BLM may permit low-ground-pressure vehicles to travel off of gravel pads and roads during periods other than when the ground is frozen and covered with snow. This is expected to be an uncommon occurrence, and if permitted

at all it would likely be only during late summer to fall. Because of restrictions that would be placed on this activity, impacts to vegetation should be limited to the compression of standing vegetation, similar to what happens during winter following traffic by low-ground-pressure vehicles.

Air Pollution. The potential for impacts to vegetation from air pollution would be slightly greater under Alternative C, given the potential for additional oil fields and processing facilities, as compared to the other alternatives. However, it is unlikely that impacts to vegetation from pollutants would substantially alter the plant communities in the planning area.

Effects of Abandonment and Rehabilitation

Under Alternative C, impacts to vegetation from abandonment and rehabilitation activities would be greater than under other alternatives, because there would be a greater extent of gravel fill to rehabilitate. During abandonment activities, vegetation and wetlands would be impacted by dust fallout along roads, by ice roads and other off-road tundra travel associated with dismantling of pipelines and power lines, and by disturbance to vegetation adjacent to VSMs and power line poles during their removal. The level of impact from these activities would be roughly the same as that during construction if gravel fill was removed; impacts would be less if the gravel were to be left in place. If roads and pads were left in place, and especially if cross drainage across roads was not maintained, water impoundment would occur, and could alter plant communities as described for the construction period. It is also likely that the unmaintained roads would have occasional washouts, where tundra vegetation would be covered with washed-out gravel. Roads and pads, if left in place, would likely need to be revegetated with plants native to gravel bars and ridges in the Arctic (i.e., different from the plant communities surrounding the facilities). Revegetation activities could take several years, as initial attempts are not always successful. Removal of gravel from pads, roads, and airstrips could be mandated. Partial or complete removal of gravel can result in faster reestablishment of native plant growth, although establishment can take many years (more than a decade). In addition, thaw subsidence is difficult to predict, and complete restoration to preexisting conditions is improbable.

Effects of Spills

The greater amount of leasing, development, and production of oil that would occur under Alternative C, relative to the other alternatives, would result in a greater number of small spills of crude and refined oil in the planning area. The chance of a large oil spill occurring would also be greater under Alternative C; however it would still be a rare event.

Most oil spills cover less than 500 square feet (<0.01 acres), although a pressured aerial mist may cover up to 145 acres (Ott 1997).). (Such a spill is a very low probability event, occurring less than once out of the total spills expected throughout the life of this Plan. Thus its magnitude is not apparent in the following acreages.) The average spill would cover 0.1 acre. If 11% of all oil spills would reach vegetation during summer, under Alternative C this would mean 275 of the 2,503 crude and refined oil spills assumed to occur over the life of the plan would have more than a negligible effect on vegetation. Assuming the average spill would cover 0.1 acre, under Alternative C approximately 27.5 acres would be impacted substantially during the lifetime of development in the planning area. This is about 39% more than the acreage impacted under Alternative A and 27% more than under Alternative B. Overall, past spills on

Alaska's North Slope have resulted in minor ecological damage and ecosystems have shown good potential for recovery (Jorgenson 1997).

Commercial Gas Development

The 182-mile-long buried gas pipeline projected for Alternative C (20 miles longer than in the other alternatives) would destroy or alter proportionately more vegetation than the other alternatives. It would destroy approximately 90 acres of vegetation directly through excavation of a 4-foot-wide trench and, potentially, alter 240 acres along an approximately 11-foot-wide strip where compaction and other indirect effects from use of machinery and temporary storage of overburden would occur. Other impacts would be similar to those for the other alternatives, including destruction of vegetation over 10 to 20 acres for a compressor station pad.

4.5.5.3 Effectiveness of Stipulations and Required Operating Procedures

Alternative C would have the same lease stipulations and ROPs as those outlined under Alternative B. Under Alternative C, development in the planning area would result in greater impacts to vegetation and plant communities compared to other alternatives, due to the greater extent of gravel fill. The ROPs and lease stipulations associated with Alternative C would reduce impacts by minimizing destruction of vegetation and alteration of plant communities.

4.5.5.4 Conclusion

Under Alternative C, impacts to vegetation from activities other than oil and gas development would be similar to those under Alternatives A and B, and would include minor impacts from aircraft landings, archaeological and paleontological excavations, camps, and overland moves. The duration of these impacts would be short term ranging up to 5 months, and recovery would vary from 1 to several years.

As for other alternatives, impacts to vegetation from oil and gas exploration under Alternative C would occur from seismic work and construction of well cellars during exploratory drilling and the construction of ice roads and ice pads. The duration and recovery time for impacts associated with seismic work would be similar to those for overland moves and the same as for Alternatives A and B. Based on earlier studies, there should be no substantial, long-term impacts to vegetation from seismic lines, but camp move trails could substantially impact approximately 153 acres after 8-9 years. Effects of well cellar construction would also be permanent, but would impact only 1.3 acres of vegetation.

Under Alternative C, the effects of oil and gas development and operation would include destruction of vegetation during construction of gravel pads (CPFs, satellite drill pads, pump stations, and staging bases), roads, airstrips, and staging areas; from excavation of material sites and burial of gas pipelines; and construction of VSMs. These impacts would be long-term and would impact about 4,649 acres, or 0.1% of the 4.6 million acre planning area (as compared to 0.07% under Alternative A or 0.08% under Alternative B). (An additional 90 acres would be destroyed through burial of gas pipelines). Plant communities could also be altered by dust deposition, salinity of gravel fill used in construction, snow drifts, and blockage of or change to natural drainage patterns. These impacts would be also be long-term and would impact about 13,001 acres, or 0.3% of the planning area (39% more than the amount of vegetation impacted under Alternative A, or 28% more than under Alternative B).

It is assumed that impacts to vegetation types or communities would occur in proportion to their occurrence within the planning area. However, increased development in the area around Teshekpuk Lake, and across the 213,000 acres that would be off-limits to oil and gas leasing and development under Alternative B but would be open to leasing under Alternative C, could disproportionately impact wet vegetation classes compared to those alternatives. A higher percentage of wet vegetation communities occur in areas in the northern portion of the planning area. This area is also considered to have the highest potential for oil reserves, which would increase the likelihood that these areas would be developed under Alternative C.

Under Alternative C, development would be unlikely to substantially affect any common plant species or communities. However, if development facilities were constructed in an area containing a population of a rare plant species, the impacts to that species could be severe. Three rare North Slope, plant species are known to occur in the planning area, and four other rare species are known to occur on the North Slope but have not been documented in the Northeast NPR-A. Sabine grass is an aquatic grass that occurs between the pendent grass and sedge zones in lakes and ponds. This species is known from a few locations north and northeast of Teshekpuk Lake, which would be protected from development under Alternatives A and B, and may be protected under Alternative D, but would not be protected under Alternative C. Stipulated cinquefoil has been found at Umiat. This Asian species is found in sandy substrates, such as sandy meadows, and riverbank silts and sands other than dunes. This species would be protected by setbacks along rivers in the planning area and by the designation of the Colville River Special Area. Muir's fleabane, Drummond's bluebell, and Hartz's bluegrass all occur in dry habitats associated with bluffs, floodplains, river terraces, sand dunes, rocky outcrops and fellfields. These habitats are the primary sources of gravel fill used during construction and development (NRC 2003), and could be impacted by development in these areas.

Impacts to vegetation from non-oil and gas activities, and from oil and gas activities, would likely be additive, except in those areas where the two types of activities overlapped. Impacts to vegetation from exploration and development activities would also be additive, except where development activities occurred in areas previously disturbed during exploration. In areas where two or more activities occurred, overall impacts would reflect those impacts associated with the first activity and any new impacts associated with later activities.

4.5.6 Wetlands and Floodplains

An additional 211,000, 213,000 and 600,000 acres would be available for oil and gas leasing under this alternative as compared to the Alternative D, Alternative B, and Alternative A, respectively. Thus, impacts to wetlands and floodplains could be greater under this alternative if development occurs in areas closed to leasing under the other alternatives, or more areas are explored and developed under this alternative than under the other alternatives. However, ROPs and performance-based lease stipulations for Alternative C would limit impacts to wetlands and floodplains. Setbacks from rivers, streams, and fish-bearing lakes would be in the range of ¼ to 3 miles under Alternative C. Approximately 95% of the planning area would be considered wetlands, according to established criteria for determining wetland status. It is likely and therefore assumed that all ground-disturbing actions will be impacting wetlands for the purposes of calculating short and long-term impacts.

4.5.6.1 Activities Not Associated With Oil and Gas Exploration and Development

Activities not related to oil and gas exploration and development that could occur in the planning area under Alternative C include aircraft, watercraft, OHV and snowmachine use, overland moves, collection and excavation for scientific research, hunting camps, recreational use of the area, and use of the area by local natives for subsistence. These activities could occur throughout the planning area, and at the same frequency and intensity as under Alternative A, despite the increased availability of land for oil and gas leasing. There could be some increased use of OHVs in the planning area due to an increase in the amount of roads associated with development. However, additional impacts to wetlands and floodplains from this increase would likely be small.

4.5.6.2 Oil and Gas Exploration and Development Activities

The following analysis is based on **section 4.2.1.2, *Oil and Gas Exploration and Development Activities.*** See that section for a description of how estimated areas of disturbance were calculated for each alternative.

Effects of Disturbances

Various activities associated with oil and gas exploration, development and production could impact wetlands and floodplains in the planning area. These activities include seismic operations, exploration drilling, construction of ice roads and ice pads, summer tundra travel, gravel roads, gravel pads for pump stations, CPFs, and staging bases, airstrip and pipeline construction, and gravel mine sites.

Exploration

During oil exploration, various activities could cause impacts to wetlands and floodplains in the planning area. These activities include seismic operations, exploration drilling, and construction of ice roads, pads and airstrips. The types of impacts to wetlands and floodplains from exploration activities were described in Alternative A and are similar to all Alternatives.

Under Alternative C, impacts to wetlands and floodplains from activities associated with oil and gas exploration would be greater than those that occur under Alternative A , assuming an additional 61 exploration and delineation wells will be drilled, which would increase the impacts of well cellar construction and the number and impacts of both ice pads and ice roads.

Under Alternative C, the same scenario for seismic exploration is assumed as for all Alternatives. Short-term vegetation disturbance from 2-D and 3-D operations is expected to total a maximum of 108,000 acres. Long-term disturbance is estimated to total 153 acres.

During the life of the plan, it is assumed that 120 exploration wells and 90 delineation wells, or a total of 210 wells, would be drilled from ice pads in the planning area under Alternative C. At six acres per pad, these would impact 1,260 acres of tundra, spread out over 50 years. This compares with 906 and 1020 acres of impacts from Alternatives A and B, respectively. Assuming that 4% (nine) of these would also involve an over-summer ice pad, an additional 54 acres of vegetation would be affected by ice pads.

Ice road construction would also increase in terms of total miles constructed because of an increase to seven in the number of total fields discovered and an increase from 162 to 182 miles of sales-oil pipeline. The total acreage of ice road over 50 years would be 21,763, assuming a 25-foot width for ice roads. This compares with 15,642 and 18,672 acres of impacts from Alternatives A and B, respectively. This also represents the total short-term disturbance from ice roads. Since vegetation recovery from ice road impacts is expected within a few years, it is assumed that long-term disturbance from ice roads would be negligible.

Ice airstrips are also used during exploratory drilling, and under Alternative C it is assumed that 40 ice airstrips would be constructed (20 more than Alternative A, and 10 more than Alternative B) covering 11 acres each for a total of 440 acres. These airstrips are commonly built on the grounded ice of large lakes, but if they were built over tundra they would result in impacts similar to ice roads.

The construction of well cellars during exploration requires the digging of a hole that destroys vegetation on approximately 16 square feet (0.00037 acres) of ground per well. Thermokarst associated with the disruption of thermal regime in the surrounding soil may also change the vegetation type around the well cellar to a wetter vegetation type. The impacts from 210 wells could result in 0.08 acres of vegetation being destroyed under Alternative C.

Development and Production

During oil development and production, various activities could cause impacts to wetlands in the planning area. These activities include construction of gravel pads for pump stations, staging bases and CPFs, roads, airstrips, pipelines, excavation of material sites, summer tundra travel, and construction of ice roads. Impacts of ice roads were discussed previously under the "Exploration" subheading and more thoroughly in Alternative A.

Placement of Gravel Fill. Types of impacts to wetlands and floodplains from placement of gravel fill were described in Alternative A. Construction of CPFs and associated satellite pads, roads, staging areas, and airstrips would result in the destruction of vegetation in the areas of gravel placement. Under Alternative C, seven oil fields, seven pump stations, and four staging bases would be developed, resulting in 3,847 acres of wetlands destroyed by gravel placement. This compares with 2,718 and 3,064 acres of impacts from Alternatives A and B, respectively.

The increased facilities construction and use under Alternative C would result in a larger area impacted by dust than under Alternative A. Assuming a total of 320 miles of in-field gravel roads and 7 miles of airstrips, there is a potential for a total perimeter of 654 miles. Within 30 feet of gravel fill, up to 2,378 acres of vegetation could be subject to smothering by dust and gravel, and between 30 and 150 feet, another 9,513 acres of altered vegetation for a total of 11,891 acres that could be affected by a dust shadow out to a distance of 150 feet. In general, most changes in the plant community around gravel structures would occur within 164 feet of the structure (Woodward-Clyde Consultants 1983). If all effects were to occur within this 164 foot zone, a total of 13,001 acres would be affected. This compares with 9,343 and 10,178 acres of impacts from Alternatives A and B, respectively.

Material Sites. Types of impacts to wetlands and floodplains from material sites were described in Alternative A. Gravel required for development in the planning area could be mined from existing sites east of the planning area or could be extracted from new sites developed within the planning area. Investigations to identify gravel sources in the planning area have not been conducted, but presumably would be initiated if discoveries of recoverable oil

or gas were made. Under Alternative C it is assumed that 16 material sites, each affecting 50 acres, would be needed. This would cover a total area of 800 acres, compared to 550 and 650 acres for Alternatives A and B, respectively. Excavation of the gravel mine and stockpiling of overburden would destroy wetlands and floodplains at these sites. ROP E-8 minimizes impacts to wetlands and floodplains by placing material sites outside of floodplains, or within floodplains if water reservoirs can be utilized and fish habitat increased.

Pipelines. Types of impacts to wetlands and floodplains from pipelines were described in Alternative A. Impacts under Alternative C from pipeline construction would be similar to those described for Alternative A. The total area disturbed by each VSM would be about 14 square feet or .00032 acres. About 6% of this area would be vegetation destroyed and replaced by the VSM, and the remaining portion would be potentially altered in terms of community type or species composition. Overall, 0.03 acres of vegetation would be disturbed per pipeline mile. Under Alternative C, 320 miles of gathering lines and 182 miles of sales-oil pipelines would disturb up to 15 acres of vegetation through VSM placement, compared to 12 and 13 acres for Alternatives A and B, respectively.

Summer Tundra Travel. Types of impacts to wetlands from summer tundra travel were described in Alternative A. Given the potentially greater number of fields developed, impacts from summer tundra travel under Alternative C could also be greater than under Alternative A. Short-term, minor impacts are expected from limited summer tundra travel using low ground pressure vehicles. ROP L-1 is designed to regulate and monitor summer travel. Summer travel would be permitted on a case-by-case basis if the applicant can demonstrate that the proposed use would have no more than minimal impacts to soils and vegetation.

Stream Crossings. Types of impacts to floodplains and stream crossings from installation of culverts, bridges or pipelines were described in Alternative A. An additional 90 miles of infield gravel roads and two additional airstrips, CPFs, and nine more production pads are expected under Alternative C than under Alternative A. For this reason it is expected that more stream crossings will be needed, and the potential for constricting flows and creation of increased stream velocities, ice jams, ice impacts, scour and streambank erosion would be greater under Alternative C. However, ROP E-6 is protective of stream crossings by requiring crossings to be designed and constructed to maintain natural drainage and minimize adverse effects to natural stream flow.

Abandonment and Rehabilitation

Alternative C may require removal of structures or rehabilitation of an additional 1,380 acres more than Alternative A and 934 acres more than Alternative B. During abandonment activities, vegetation and wetlands would be impacted by dust fallout along roads, by ice roads and other off-road tundra travel associated with dismantling of pipelines and power lines, and by disturbance to vegetation adjacent to VSMs and power line poles during their removal. The level of impact from these activities would be roughly the same as that during construction if gravel fill was removed; impacts would be less if the gravel were to be left in place. If roads and pads were left in place, and especially if cross drainage across roads was not maintained, water impoundment would occur, and could alter plant communities as described for the construction period. It is also likely that the unmaintained roads would have occasional washouts, where tundra vegetation would be covered with washed-out gravel. Roads and pads, if left in place, would likely need to be revegetated with plants native to gravel bars and ridges in the Arctic (i.e., different from the plant communities surrounding the facilities). Revegetation activities could take several years, as initial attempts are not always successful. Removal of gravel from

pads, roads, and airstrips could be mandated. Partial or complete removal of gravel can result in faster reestablishment of native plant growth, although establishment can take many years (more than a decade). In addition, thaw subsidence is difficult to predict, and complete restoration to preexisting conditions is improbable. Lease Stipulation G-1 would provide for the removal of all oil and gas facilities at the time of field abandonment unless the AO determined that facilities should be left in place.

Effects of Spills

The greater amount of leasing, development, and production of oil that would occur under Alternative C, relative to Alternative A, would result in a greater number of small spills of crude and refined oil in the planning area. The chance of a large oil spill occurring would also be greater under Alternative C; however, it would still be a very rare event.

Most oil spills cover less than 500 square feet (<0.01 acres), although a pressured aerial mist may cover up to 145 acres (Ott 1997). (Such a spill is a very low probability event, occurring less than once out of the total spills expected throughout the life of this Plan. Thus its magnitude is not apparent in the following acreages). See **section 4.3.5.2** under the vegetation section for a more thorough analysis of potential impacts to vegetation and wetlands from spills. If 11% of all oil spills would reach vegetation during summer under Alternative C this would mean 275 of the 2,503 spills assumed to occur over the life of the plan would have more than a negligible effect on vegetation. This compares with 197 and 228 spills assumed with Alternatives A and B, respectively. Assuming the average spill would cover 0.1 acre, under Alternative C approximately 27.5 acres would be impacted substantially during the lifetime of development in the planning area. Overall, past spills on Alaska's North Slope have resulted in minor ecological damage and ecosystems have shown good potential for recovery (Jorgenson 1997).

Commercial Gas Development

Development of commercial gas in the planning area under Alternative C would reflect the impacts described for soils, water, and vegetation and would be similar, but greater than that described for the other alternatives. The greater length of buried gas pipelines (182 miles rather than 162 miles) projected in this alternative would be the primary reason for greater impacts, Alternative C (like Alternatives B and D) makes more lands available in ice-rich areas especially susceptible to thermokarst, subsidence and erosion, and thus could have greater impacts from burying a gas pipeline than Alternative A. Placement of gas pipelines on VSMs, would reduce these impacts, though vegetation and soils would be destroyed at base of the VSMs, vegetation under aboveground pipelines would be impacted by shading, and ice roads that may be used during construction would have localized, short-term impacts on vegetation and during spring melting add somewhat saline water to any shallow tundra pools.

4.5.6.3 Effectiveness of Stipulations and Required Operating Procedures

Alternative C would have the same performance-based lease stipulations and ROPs as those outlined under Alternative B and be equally protective as those of the prescriptive stipulations in Alternative A. Development in the planning area under Alternative C would result in impacts to wetlands and floodplains greater than those from the other alternatives due to greater amounts of gravel fill. The ROPs and lease stipulations associated with Alternative C would be effective in minimizing destruction of wetlands and floodplains.

4.5.6.4 Conclusion

Under Alternative C, impacts to wetlands and floodplains from activities other than oil and gas development would be similar to those under Alternatives A and B, and would include minor impacts from aircraft, watercraft, OHV and snowmachine use, overland moves, collection and excavation for scientific research, hunting camps, recreational use of the area, and use of the area by local natives for subsistence. The duration of these impacts would be short term, ranging up to 5 months, and recovery would vary from one to several years.

Under Alternative C, impacts to wetlands and floodplains from oil and gas exploration would be greater than the other alternatives and would involve seismic work, construction of well cellars during exploratory drilling, and the construction of ice roads, pads and airstrips. The duration and recovery time for impacts associated with seismic work would be similar to those for overland moves and the same as for Alternatives A and B. Based on earlier studies, there should be no substantial, long-term impacts to vegetation from seismic lines, but camp move trails could substantially impact approximately 153 acres after 8-9 years. Effects of well cellar construction would also be permanent, but would impact only 0.08 acres of vegetation.

The effects of oil development and operation under Alternative C would include destruction of wetlands during construction of gravel pads, roads, airstrips, and staging areas; from excavation of material sites; and construction of VSMs. These impacts would be long-term and would impact about 4,649 acres, (compared to 3,270 and 3,716 acres impacted by Alternatives A and B, respectively) or 0.1% of the 4.6 million acre planning area. Wetland plant communities could also be altered by dust deposition, salinity of gravel fill used in construction, snow drifts, and blockage of or change to natural drainage patterns. These impacts would be also be long-term and would impact about 13,001 acres, (compared to 9,343 and 10,178 acres impacted by Alternatives A and B, respectively) or 0.3% of the planning area.

It is assumed that impacts to wetlands and floodplains would occur in proportion to their occurrence within the planning area. However, increased development in the area around Teshekpuk Lake, and across the 213,000 acres that would be off-limits to oil and gas leasing and development under Alternative B but would be open to leasing under Alternative C, could disproportionately impact wetlands since a higher percentage of wet vegetation communities occur in areas in the northern portion of the planning area. This area is also considered to have the highest potential for oil reserves, which would increase the likelihood that these areas would be developed under Alternative C.

Impacts to wetlands and floodplains from non-oil and gas activities, and from oil and gas activities, would likely be additive, except in those areas where the two types of activities overlapped. Impacts to wetlands from exploration and development activities would also be additive, except where development activities occurred in areas previously disturbed during exploration. In areas where two or more activities occurred, overall impacts would reflect those impacts associated with the first activity and any new impacts associated with later activities.

4.5.7 Fish

4.5.7-a Freshwater and Anadromous/Amphidromous Fish

4.5.7-a.1 Activities Not Associated With Oil and Gas Exploration and Development

It is expected that the frequency and intensity of most non-oil and gas activities occurring under Alternative C would be similar to those occurring under Alternative B and Alternative A. Ground camps in support of research may increase in association with the projected increase in oil and gas activity under Alternative C, and subsistence fishing could potentially occur in more areas due to increased access. However, additional impacts to fish from this increase would likely be small.

4.5.7-a.2 Oil and Gas Exploration and Development Activities

Effects of Disturbances

Effects from Seismic Surveys. Potential threats to overwintering fish from seismic surveys in the planning area would include 1) physical damage or acute mortality from acoustic energy pulses; 2) stress associated with acoustic energy pulses; and 3) physical damage to overwintering habitat caused by seismic vehicles. Given that overwintering habitat represents only about 5% of the planning area, it is unlikely that seismic transmissions would occur directly over overwintering sites with any degree of regularity. Overall, any affects to overwintering fish caused by winter seismic surveys would be localized and would not be likely to have any measurable effect on fish populations within the planning area.

Under Alternative C, seismic exploration in Teshekpuk Lake could occur during the summer open water period using airgun arrays and explosives (although the use of explosives is unlikely). Impacts from Vibroseis and airgun arrays under Alternative C would be identical to those described for other alternatives.

Explosives, in comparison to airguns and Vibroseis, are generally more detrimental to fish (Wright and Hopky 1998). The received impulse depends on the mass of the charge, the depth of the charge, the distance from the charge to fish, and the depth of the fish. The peak pressure generated by an airgun array is less than that produced by a small charge of explosives. Most blast injuries to fish involve damage to air or gas-containing organs (Yelverton 1981), although damage to solid organs and other tissue has also been observed (Wright 1982). All of the species of fish present in Teshekpuk Lake have swim bladders and would be vulnerable to explosives. During exposure to shock waves, the swim bladder oscillates and may rupture, causing hemorrhages in nearby organs. In extreme cases, the oscillating swim bladder may rupture the body wall of the fish. The use of explosives in Teshekpuk Lake would likely result in the mortality of some fish present in the lake. The number of fish impacted would depend on the frequency and size of the charge used and the location of charges relative to fish in the lake. Juvenile fish would be more vulnerable to damage, as explosives have a greater impact on fish as body weight decreases (Yelverton et al. 1975).

The level of seismic activity may be higher under Alternative C than under Alternative B and Alternative D, but any impacts would be localized. Therefore, seismic activities associated with

Alternative C are expected to be minor and not have a measurable effect on fish populations within and adjacent to the planning area.

Effects from Water Demand. Most freshwater bodies less than 6 feet in depth typically freeze to the bottom. It has been estimated that by late winter, ice cover can decrease available freshwater habitat in North Slope rivers and streams by approximately 97% (Craig 1989b). Overwintering areas are therefore limited to deep-water pools and channels in rivers and streams, and to lakes deep enough to provide sufficient under-ice free water during winter. In standing waters, 7 feet is considered the minimum depth for supporting overwintering fish (PAI 2002). Because of the importance of limited overwintering area to Arctic fish, ROPs and lease stipulations specifically regulate the winter withdrawal of water from lakes, rivers, and streams. Under Alternative C, the general level of protection to fish and fish habitat offered by ROPs and lease stipulations would be similar to those for the other alternatives. Under Alternative C, water withdrawal would increase proportionately to increased exploration and development; however, careful adherence to ROPs and lease stipulations should offer adequate protection to fish. Winter water withdrawal associated with Alternative C should not have a measurable effect on freshwater, anadromous, or amphidromous fish populations within and adjacent to the planning area.

Effects from Exploratory Drilling. Under Alternative C, the general level of protection to fish and fish habitat offered by ROPs and lease stipulations would be similar to those developed for Alternative A and Alternative B. The number of exploratory wells could increase by about 40% under Alternative C relative to Alternative A, but the prohibition of drilling in rivers and streams should mitigate some impacts to fish. Therefore, exploratory drilling activities associated with Alternative C should not have a measurable effect on freshwater, anadromous, or amphidromous fish populations within and adjacent to the planning area.

Effects from Gravel Extraction. Under Alternative C, the general level of protection to fish and fish habitat offered by ROPs and lease stipulations would be less than that for Alternative A and Alternative B because more gravel extraction sites are anticipated under Alternative C. However, gravel extraction would not be expected to have a measurable effect on freshwater, anadromous, or amphidromous fish populations within and adjacent to the planning area under Alternative C, and could even enhance habitat.

Effects from Pad, Road, and Pipeline Construction. Relative to Alternative A, a greater number of pads and roads, and pipelines would be constructed under Alternative C, and would be dependent on the amount of recoverable oil and gas reserves eventually brought into production. There would also be higher number of these features in comparison to Alternative B. Rigorous adherence to pre-development environmental assessment, structure siting, and construction codes should minimize some impacts to fish from construction and operation-related impacts. Under Alternative C, impacts to fish and fish habitat offered by ROPs and lease stipulations would be nearly identical to that discussed under Alternative A and Alternative B. The construction and placement of drill pads, roadways, pipelines, bridges, and culverts under Alternative C should not have a measurable effect on freshwater, anadromous, or amphidromous fish populations within and adjacent to the planning area.

Effects from Summer Tundra Travel. The use of low-ground-pressure vehicles for tundra travel during the summer may be necessary for pipeline inspection, maintenance, and spill prevention activities. Under Alternative C, the same protections would be provided for fish as in Alternative B (L-1 ROP), although the potential for an impact would be slightly higher because of the increased extent of pipeline. Summer tundra travel under Alternative C should not have

a measurable effect on freshwater, anadromous, or amphidromous fish populations within and adjacent to the planning area.

Effects from Causeways. Under Alternative C, the general level of protection to fish and fish habitat mitigated by ROPs and lease stipulations would be similar to that discussed under the Alternative B, but likely greater than Alternative A. The future construction of a causeway or dock could have a minor effect on anadromous, and amphidromous fish populations under Alternative C.

Effects from Waterflooding. Oil fields in the northern portion of the planning area would likely receive seawater from facilities already serving fields in the Prudhoe Bay/Kuparuk area under Alternative C. These facilities, which have been operational for years, have not been shown to have a serious effect on fish migrating or foraging in the intake area. If seawater intake facilities were constructed in the future to enhance supply to oil fields in the planning area, it is assumed that the same design safeguards would be incorporated to prevent the entrainment and impingement of fish. Under Alternative C, waterflooding would not be expected to have a measurable effect on anadromous and amphidromous fish. Nonetheless, under this alternative, it is projected that impacts to fish from seawater facilities would be greater than under other alternatives.

Effects of Abandonment and Rehabilitation

Water withdrawal and removal of bridges, culverts, and bridge approaches could have impacts on fish similar to those described for construction activities. Additional fish habitat could be created by allowing gravel pits to be colonized by fish from nearby streams.

Effects of Spills

Under Alternative C, the general level of protection to fish and fish habitat offered by ROPs and lease stipulations would be nearly identical to those discussed under the other alternatives. Potential impacts are the same as those described under Alternative A.

Under Alternative C, the volume of spills and expected amount of impact would increase proportionately (from Alternative A) with increased exploration and development. In Alternative C, the volume of oil from small and large spills is projected to be 39% more than the volume from spills estimated to occur under Alternative A. Given the small volume of oil typically involved in small spills, as well as the safety requirements for operations in the oil field and stringent clean-up protocols, small oil spills associated with Alternative C would not likely have a measurable effect on freshwater, anadromous, or amphidromous fish populations in or adjacent to the planning area. Besides the effectiveness of the response, many independent factors will determine the probability that fish will be negatively impacted by an oil spill, including the quantity spilled, season, weather patterns, location (e.g. upland versus river channel), and proximity to sensitive habitat (see **section 4.2.2.3, *Fate and Behavior of Spilled Oil***). If a large spill of crude oil occurred during the summer open-water period and within a major stream or river channel, this could potentially have an effect on freshwater, anadromous, or amphidromous fish populations in or adjacent to the planning area; in particular, impacting subpopulations at the drainage level. A very large oil spill within a major stream or river channel during the summer would have an even more likely impact on freshwater, anadromous, or amphidromous fish populations in or adjacent to the planning area.

Commercial Gas Development

Impacts of commercial gas development under Alternative C would be similar to those described for Alternatives A and B, though the potential for impacts would be about 12% higher because Alternative C could result in more buried gas pipeline. Winter construction of a buried gas pipeline by trenching through fish inhabited streams or portions of streams not frozen to the bottom would impact fish to some degree, depending on the volume of the overwintering habitat and the density of fish utilizing this habitat. Potential impacts to fish associated with maintenance of gas pipelines would be similar to those described for construction. Water withdrawals and changes to hydrology caused by ice roads could affect fish. Potential issues include losing access to suitable habitat, barriers to movement, or habitat degradation. These ice roads would be necessary during both natural gas exploration and construction phases. For example, ice roads would be used to reach exploration drilling sites and also used in trenching the pipeline route or construction of a compressor station (ADNR, 2006b). If a buried gas pipeline ruptured and gas escaped to a fish-bearing waterbody, some fish in the immediate vicinity might be killed. Natural gas and condensates would be hazardous to any organisms exposed to high concentrations. In general, very few fish are likely to be affected by a pipeline rupture.

While natural gas exploration and development may have notable localized impacts, it is not likely to have a measurable effect on freshwater fish populations.

4.5.7-a.3 Effectiveness of Stipulations and Required Operating Procedures

The effectiveness of lease stipulations and ROPs in protecting freshwater, anadromous, and amphidromous fish and fish habitat under Alternative C is identical to the effectiveness of those for Alternative B, and similar to those developed for Alternative D and for stipulations under Alternative A.

4.5.7-a.3 Conclusion

Activities proposed under Alternative C should have only minor effects on fish and their habitats. By opening up additional lands near Teshekpuk Lake to leasing, fish in this lake and other deep-water lakes and streams would have a greater potential to be impacted by spills and habitat degradation, resulting in greater risks to fish under this alternative than under the other alternatives.

In general, impacts to fish from non-oil and gas activities, and from oil and gas activities, would likely be additive, except in those areas where the two types of activities overlapped. Impacts to fish from exploration and development activities would also be additive, except where development activities occurred in areas previously disturbed during exploration. However, once exploration and development/production cease in an area, fish populations and habitat could recover, reducing overall effects in the planning area. Surface disturbance and spill-related impacts associated with Alternative C are projected to be greater than for Alternative A. Performance-based ROPs and lease stipulations developed for this alternative, however, would ensure the exploration and development activities are set back from fish habitats and that procedures are in place to clean up most spills before they can harm fish or their habitats.

4.5.7-b Marine Fish

4.5.7-b.1 Activities Not Associated With Oil and Gas Exploration and Development

Most non-oil and gas activities, including recreational fishing, would be quite limited in scope and duration. In addition, recreational and commercial fishermen do not target marine fish in the Beaufort Sea. Therefore, it is not expected that non-oil and gas activities occurring under the Alternative C would have a measurable effect on marine fish in the vicinity of the planning area.

4.5.7-b.2 Oil and Gas Exploration and Development Activities

Effects of Disturbances

Effects from Seismic Surveys. Seismic surveys could be conducted within the planning area during the winter months, from early December to mid-May and on Teshekpuk Lake during the summer. Because marine fish and their habitat lie outside the planning area in winter and Teshekpuk Lake during the summer, seismic activities associated with Alternative C would not be expected to have a measurable effect on marine fish populations.

Effects from Water Demand. Water used in the building of drill pads, roads, and airstrips would likely be withdrawn from freshwater sources proximal to the site of construction. These activities would have no effect on marine fish or their environment. Water withdrawal for the purposes of waterflooding, which would have implications for the marine system, is discussed separately below under the "Effects from Waterflooding" subheading.

Effects from Exploratory Drilling. Most exploratory drilling would be conducted within the planning area during the winter months, from early December to mid-April. Because marine fish and their habitat lie outside the planning area in winter, most exploratory activities associated with Alternative C would not be expected to have a measurable effect on marine fish populations. Exploratory drilling could also be conducted from current production pads or platforms within a lake body during summer in the TLCH Area, but impacts to marine fish would be minor.

Effects from Gravel Extraction. It is doubtful that gravel extraction would be permitted along the coastal tidal zone. Small numbers of fourhorn sculpin and Arctic flounder could migrate upriver in summer, but any encounter with a gravel site would be a chance occurrence, and would involve only a minor segment of any population. Fourhorn sculpin and Arctic flounder regularly inhabit and forage in highly turbid coastal waters near river outfalls and plumes. Gravel extraction would not benefit fish populations by creating overwintering habitat, as it might for freshwater fish, since all marine fish overwinter at sea.

Effects from Pad, Road, and Pipeline Construction. Under Alternative C, a greater number of pads, roads, and pipelines associated with expanded exploration and development activities relative to Alternative A would occur, primarily inland rather than in coastal areas. The construction of pads, therefore, is not expected to have a measurable effect on marine fish populations within and adjacent to the planning area under Alternative C. Under Alternative C, the general level of protection to freshwater, anadromous, and amphidromous fish and fish

habitat offered by ROPs and lease stipulations for this alternative would be nearly identical to those developed for Alternative A.

Effects from Causeways. Under Alternative C, restrictions on the use, design, and monitoring of causeways that might be constructed along the coast in the future would be nearly identical to those discussed under Alternative A. Any future construction of causeways or docks would not be expected to have a measurable effect on marine fish populations within and adjacent to the planning area even if there were a greater level of activity associated with exploration and development, relative to the other alternatives.

Effects from Waterflooding. Under Alternative C, waterflooding is not expected to have a measurable effect on marine fish, for the same reasons given above for anadromous and amphidromous fish, even if there were a greater level of activity associated with exploration and development, relative to the other alternatives.

Effects of Spills

The threat to marine fish from an oil spill is contingent upon the spill reaching coastal waters at volumes capable of affecting large nearshore areas. Because oil spills in the planning area are expected to be small, and given the stringent oil-spill-response safety requirements for operations on the oil field, there is a minor likelihood that an inland spill would reach coastal/marine waters of the planning area at volumes capable of causing a biologically measurable impacts to marine fishes.

Commercial Gas Development

Marine fish populations are not expected to be affected by exploration, construction, or maintenance activities associated with a gas development beyond what is expected to occur during oil development.

4.5.7-b.3 Effectiveness of Stipulations and Required Operating Procedures

Under Alternative C, the general level of protection to fish and fish habitat offered by lease stipulations and ROPs would be identical to that discussed under Alternative B, and similar to that for Alternative D. Lease Stipulation K-6 specifically prohibits permanent oil and gas development within ¾ mile inland from the coastline, unless the AO grants an exception. Thus, greater protection is afforded marine fish under the Alternative C than Alternative A.

4.5.7-b.4 Conclusion

In general, marine fishes of the Beaufort Sea are insulated from many potential environmental impacts associated with oil and gas development in the planning area. Most of the coastal tidal area of the planning area is shallow and lies within the winter landfast ice scour zone. Thus, the marine habitat and the fish occupying it are outside the planning area proper during winter and would not be subject to disturbances associated with seismic surveys, exploration drilling, and water withdrawal. Although species like fourhorn sculpin and Arctic flounder may move upriver during summer, most members of these marine species remain in shallow coastal waters. The bulk of the population would not be directly subject to the effects of river gravel extraction; pad, road, and pipeline construction; sedimentation from gravel erosion; and the potential blockage of migratory corridors.

Because marine species are abundant and widely distributed throughout the Beaufort Sea, it is also highly unlikely that any point impact associated with oil and gas development in the planning area (the occurrence of which is unlikely) could substantially affect these marine species at the population level. One exception might be a catastrophic oil spill that could cause sublethal genetic or physiological abnormalities that might be propagated through the broader population. However, given that oil spills in the planning area are expected to be small, and the stringent oil-spill-response safety requirements for operations on the oil field, such an event is unlikely.

Overall, impacts to marine fish resources under Alternative C would be greater than those that would be expected to occur under Alternative A and Alternative B.

4.5.8 Birds

This section discusses the potential effects to birds that could result from management action in the planning area under Alternative C. A discussion of effects to threatened and endangered bird species is given in **section 4.5.10, *Threatened and Endangered Species*.** Most of the activities that could potentially affect birds in the planning area would result from oil and gas exploration and development. Other activities that could potentially affect birds in the planning area include subsistence activities (including hunting, fishing, berry picking etc.), recreational use, activities associated with scientific surveys and research camps, clean up of old oil and gas exploration sites, and activities associated with government actions (e.g. clean up of abandoned well sites). These activities could affect tundra nesting birds by causing: 1) temporary or permanent habitat loss; 2) various types of disturbance related to equipment and facility noise, vehicular and air traffic, and pedestrian activities, which could result in displacement from preferred foraging, staging, nesting and/or brood-rearing habitats or decreasing productivity and survival; 3) increased predation from predators attracted to areas of human activity; and 4) mortality resulting from collisions with vehicles or structures, or exposure to contaminants, including oil spills. Alternative C makes 100% of the planning area's 4.6 million acres available for oil and gas leasing (Map 2-3). It would utilize the same performance-based stipulations and ROPs developed for Alternative B to mitigate the impacts of energy development and other land uses on resources in the planning area. These protective measures would mitigate the impacts of energy development and other land uses, provide flexibility to BLM to adapt management decisions to uncertain or changing environmental conditions, and provide more consistent management by BLM across the entire northern portion of NPR-A.

4.5.8.1 Activities Not Associated With Oil and Gas Exploration and Development

Under Alternative C, activities not related to oil and gas exploration and development that could affect birds in the planning area would be the same as those described under the other alternatives: private or commercial air traffic, aerial surveys to inventory wildlife or other resources, summer research camps, hazardous material or debris removal, subsistence hunting and fishing, and recreational camps and boating activity. Impacts to birds under Alternative C could be more frequent, greater in extent, or longer in duration than would occur under Alternative A. A greater number of individual animals would be exposed to human activities. Aircraft traffic would more often pass over birds during flights to or from the camps and along aerial survey routes. The disturbance reactions of birds would likely be brief, lasting for a few minutes to an hour. Some birds might avoid inventory survey and recreation camps during the 6 to 12 weeks of activities, while ravens could be attracted to the camps. Lease stipulations to

protect waterfowl, shorebirds, raptors, and other birds and their habitats would help to mitigate the potential effects of non-oil and gas activities on birds under Alternative C.

4.5.8.2 Oil and Gas Exploration and Development Activities

Effects of Disturbances

Seismic Exploration

Most seismic surveys to collect geological data and exploration drilling activities would occur during the winter months when most birds are not present in the planning area. Under Alternative C, the types of effects of winter exploration activities on the bird species that would be present in the planning area would be the same as those discussed under the other alternatives. Although impacts associated with winter exploration would likely be minor under Alternatives A, B and C, there could be a greater effect to birds under Alternative C because areas of greater bird habitat value and use would be available for exploration than under Alternatives A or B, it is expected that the same number of seismic surveys will occur under all alternatives (see **section 4.2.1.2**). The direct effects of exploratory activities would likely include the temporary displacement of a small number of birds (e.g. ptarmigan) from preferred winter feeding or roosting areas.

During winter exploration activities, potential indirect impacts to birds could result from the construction of ice roads and ice pads and the associated water withdrawal. The types of effects that could result from ice road and ice pad construction under Alternative C would be the same as those described under the other alternatives, and would primarily involve the temporary alteration of tundra habitats. Water withdrawal for ice road construction could also temporarily alter habitats adjacent to water source lakes, which could affect nesting or brood-rearing loons and waterfowl. Rolligons and track vehicles used during winter exploration could also temporarily affect tundra vegetation, resulting in minor impacts to tundra habitat of nesting birds. A larger area would be available for oil and gas exploration activities under Alternative C, as compared to the other alternatives. Therefore, the potential impacts resulting from exploratory activities would also be greater under Alternative C. Under Alternative C, moderate effects to birds could occur in the Goose Molting Area, the entire area of which would be unavailable for oil and gas leasing under Alternative A and portions of which would be unavailable for leasing under Alternative B. However, Lease Stipulation K-4 may mitigate some potential impacts in the Goose Molting Area by prohibiting water extraction and other oil and gas activities that could affect goose feeding habitat along lakeshore margins. Currently there is little known as to why geese use the Goose Molting Area in such large concentrations and impacts to vegetation or impoundments and delayed drainage due to ice roads may have a negative effect on the habitat used by molting geese.

The use of airguns for boat-based seismic work in Teshekpuk Lake during the summer could temporarily displace loons and waterfowl from preferred feeding habitats while surveys were being conducted. Disturbance may result not only from airgun use but also from boat activity (Rodgers and Smith 1995). Because setbacks around the perimeter of the lake presumably would eliminate the potential for disturbance to birds nesting near the lakeshore, only birds using habitats in the open water of the lake would potentially be disturbed. Birds displaced by seismic activities would likely return to preferred habitats after the airgun arrays passed through the area. Effects of use of airguns on forage fish may include stress from fleeing behavior and physical damage or death (section 4.1.1 this document) potentially resulting in a reduction in the amount of prey available to foraging loons. Disturbance to birds near and

nesting on the shoreline could result from support activities, such as use of helicopters to transport personnel and supplies. Disturbance related to support activities could result in permanent or temporary displacement from nesting, feeding, or brood-rearing habitats. Conducting surveys after the completion of the nesting and brood-rearing period would eliminate the potential for nest abandonment and loss of productivity. Although the use of explosives for seismic surveys under Alternative C is highly unlikely, it would likely cause greater disturbance than described for seismic activities using airgun arrays. For example, the use of explosives could potentially cause bird mortality if diving birds were feeding near the charge.

Predators, such as glaucous gulls, ravens, and Arctic foxes, could be attracted to anthropogenic food sources associated with summer maintenance of exploratory drilling and seismic equipment or winter exploratory activities. Increased levels of predation could have moderate impacts on tundra-nesting birds. Under Alternative C, ROPs A-2 and E-9 would help mitigate the potential effects of increased predation, and the overall effect to birds would likely increase incrementally as the amount of exploratory activity increases under the four alternatives. However, it would likely be difficult to prevent ravens from nesting on oil field structures and increased levels of predation from ravens may be difficult to mitigate under any alternative.

Oil and Gas Development

Activities on Roads and Pads. Activities related to oil development and production in the planning area, such as vehicle, aircraft, pedestrian, and boat traffic, routine maintenance activities, heavy equipment use, and oil-spill clean-up activities, could cause disturbances that would affect tundra-nesting birds. Under Alternative C, the types of disturbances to birds would be the same as those discussed under the other alternatives. These disturbances could result in moderate impacts that could result in temporary or permanent displacement of birds from preferred foraging, nesting, and brood-rearing habitats; decreased nest attendance or nest abandonment; and increased energy expenditures that could affect physiological condition, rate of survival, and reproduction. The likelihood for impacts to tundra-nesting birds would depend on the location of the disturbance, the bird species and the number of individuals in the area, and the time of year. Impacts from disturbance would most likely occur in habitats with high bird concentrations, or if species with low population numbers or declining populations, such as the buff-breasted sandpiper or yellow-billed loon, were disturbed.

The potential for disturbance to birds from activities on roads and pads would likely be greater under Alternative C, as compared to the other alternatives, because areas that support high bird concentrations occur in the Teshekpuk Lake Goose Molting Area and would be available for oil and gas leasing under Alternative C, but not under the other alternatives. This area is of international importance for molting brant and other geese, and the highest densities of nesting shorebirds in the planning area occur in areas northeast and northwest of Teshekpuk Lake (Map 3-18). Disturbance that resulted in a reduction in the breeding success of geese and other waterfowl could impact the success of subsistence and sport hunters in Alaska, the lower 48 states, Canada, Russia, and Mexico. Disturbance effects could impact shorebirds if development occurred in areas of high shorebird concentration located north of Teshekpuk Lake. Lease Stipulation K-4, however, would help to mitigate potential disturbance to birds in the Goose Molting Area by providing setbacks from lakes within which permanent oil and gas facilities would be prohibited. Lease Stipulation K-4 would also help limit impacts to goose molting lakes from excessive water extraction activities; provide for protection of shoreline habitats adjacent to these lakes; and protect the goose molting lakes from disturbance from oil and gas activities by requiring features that would screen or shield human activity from the view of any goose

molting lake, and by minimizing ground traffic from May 20 through August 20. In addition, Lease Stipulation K-6 would establish a ¾-mile buffer inland from the coast, within which oil and gas facilities would be prohibited, to the extent practicable, to minimize hindrance or alteration of caribou movement within caribou coastal insect-relief areas. This lease stipulation could also help to reduce the potential impacts to waterfowl habitats in coastal areas. Although these lease stipulations would be in place under the other alternatives, there would be a greater potential for disturbance to waterfowl and other birds under Alternative C because there would be a larger area of high bird use in which activities could occur.

Summer Tundra Travel. Alternative A allows summer tundra travel in Northeast NPR-A only through use of the stipulation exception process (see stipulation 24i in the 1998 Northeast NPR-A ROD). Travel off of gravel pads is easiest in winter and generally environmentally preferable at that time, some vehicle travel off of pads does occur in North Slope oil fields during summer to accomplish specific tasks. The State of Alaska has approved some low-ground-pressure vehicles for summer tundra travel and similar summer tundra travel may be anticipated to be part of oil development in northeast NPR-A. Alternative C contains Required Operating Procedure L-1 which was crafted with the following objective "Protect stream banks and water quality;...maintain populations of, and adequate habitat for birds, fish, and caribou and other terrestrial mammals; and support maintenance of subsistence activities." Summer tundra travel is commonly associated with spill prevention and preparedness measures required in spill prevention plans and it is anticipated that these are the types of activities that would be permitted to travel off of gravel pads and roads during times other than those identified in ROP C-2a if required surveys and studies show that minimal impacts to the resources in the area would occur. The potential for disturbance to birds from summer tundra travel would likely be greater under Alternative C, as compared to Alternatives A and B, because there are greater areas that support high bird concentrations in portions of the Goose Molting Area that would be available for oil and gas leasing under Alternative C. The reduction in the amount of habitat protected under Alternative C, as compared to Alternative A and B, would likely increase the risk of disturbance to internationally significant populations of molting geese, particularly brant that use the Goose Molting Area. The additional areas available for leasing under Alternative C could also negatively affect white-fronted, lesser snow and Canada geese. Disturbance that resulted in a reduction in the breeding success of geese and other waterfowl could also impact the success of subsistence and sport hunters in Alaska, the lower 48 states, Canada, Russia, and Mexico. Disturbance effects could also impact shorebirds if development occurred in areas of high shorebird concentration located north of Teshekpuk Lake.

Air-Traffic. Both fixed-wing aircraft and helicopters could be used to transport personnel, supplies, and equipment to airstrips or staging areas during development and production activities in the planning area. The types of disturbance effects to waterfowl and other bird groups from aircraft would be the same under Alternative C as those discussed under the other alternatives. Aircraft disturbance could have moderate impacts on tundra-nesting birds or on molting geese that could include displacement from preferred feeding habitats, temporary or permanent nest abandonment, and temporary or permanent displacement from molting and brood-rearing areas. However, some birds could acclimate to aircraft activity by either remaining in habitats located near aircraft activities, or by moving to nearby habitats. This may not be the case for brant, as they apparently do not habituate well to aircraft traffic (Derksen et al. 1992).

Compared to the other alternatives, it is likely that there would be a greater amount of disturbance to birds under Alternative C, as aircraft traffic, including take-offs and landings,

could occur in the entire Goose Molting Area, and facilities could be located in the portions of the Teshekpuk Lake Caribou Habitat Area (where surface activity was prohibited under Alternative A). Under Alternative C, Lease Stipulations K-3 through K-6 would provide setbacks from various habitats surrounding Teshekpuk Lake and along the coast that are considered important for fish, birds, and caribou in the area. Within these setbacks, permanent oil and gas facilities would be prohibited, and other potentially disturbing activities, such as vehicular and air traffic, would be restricted. These lease stipulations would help to mitigate for potential aircraft disturbance should oil and gas facilities be located within the Goose Molting Area. However, the potential for disturbance would be greater under Alternative C than under the other alternatives, given the larger area available for oil and gas leasing.

Watercraft. Several types of watercraft could be used during the summer to transport equipment and supplies and to conduct oil spill response training drills. Summer barge traffic [up to 30 barges per year with each CPF requiring 1 or 2 seasons of barge traffic depending on size], with the potential to temporarily displace feeding, molting, brood-rearing and staging waterfowl, could occur in offshore or near shore waters of the planning area from mid-July through October. The impacts of disturbance from barge traffic would likely be minor and displaced waterfowl would probably move to adjacent habitats or return to original habitats after the barges passed though the area. It is well known (Avery, Springer and Dailey 1980) that birds may be attracted to sources of light with the potential for the bird to strike a structure (building, barge, tower etc.) resulting in the possibility of mortality. There are documented accounts of waterfowl and seabirds being attracted to and colliding with ships in various light conditions (Dick and Donaldson 1978). Eiders in particular are thought to be susceptible to collision with human-made structures because they fly low over the water while migrating, fly rapidly when migrating, and are attracted to lights (Day at al. 2003 and references contained within). However, there is a short window of time during the fall when the planning area is dark and birds are present, thus the potential for collisions between staging waterfowl and barges working in the planning area is low. There would be a greater likelihood for disturbance to molting waterfowl under Alternative C than under Alternative A and B because much of the area adjacent to the coast would be open for leasing under Alternative C, but unavailable for oil and gas development under Alternative A. There could also be a potential for more offshore vessel traffic under Alternative C, as compared to Alternative A and B, given the larger area that would be available for oil and gas leasing and development in the Goose Molting Area under Alternative C. It is likely that more development would occur in the Goose Molting Area under Alternative C, which would increase the likelihood that barge traffic would be required in the offshore waters of the planning area to transport equipment and supplies necessary for development.

Oil spill response training activities using watercraft could be conducted on rivers and lakes several times during the summer open-water season. Disturbance from watercraft activity along rivers could affect birds such as ruddy turnstones, semipalmated plovers, and Baird's sandpipers that use gravel bars. The results of disturbance may include failure to nest or nest abandonment. Under Alternative C, these activities would be more likely to disturb waterfowl and other birds, than under Alternatives A and B, because there would be a greater likelihood that facilities would be located in areas of high bird use within the Teshekpuk Lake Special Area. Wildlife resource surveys would be conducted prior to development, and suitable areas for conducting spill response training, to minimize the potential disturbance to waterfowl, would be identified.

Habitat Losses and Alteration

Permanent Habitat Loss. Gravel mining and placement for the construction of oil field infrastructure would have the greatest potential to result in the loss of tundra-nesting bird habitat. During the construction of oil field roads and pads, tundra covered by gravel, as well as tundra associated with gravel mine sites, would be lost as nesting, brood-rearing, and foraging habitat for birds. Under Alternative C, it is estimated that there will be a need for seven central processing facilities (90 acres each) in the planning area. In conjunction with these facilities there are other support structures, such as gravel production pads, gravel runways in-field gravel roads, several types of pipelines, and other associated structures, that will also cause surface disturbances. It is estimated that under Alternative C, there will be: 32 gravel production pads (10 acres each); 7 gravel runways (11 acres each); 320 miles of in-field gravel roads (7.75 acres/mile); 320 miles of three-phase produced fluids (oil, gas, water) gathering lines; 182 miles of sales oil pipelines; 7 pump stations (20 acres each);4 staging bases (50 acres each); and 16 gravel pits (50 acres each). It is estimated that during the construction phase of these facilities that the total short term disturbance would be 6,170 acres. During the production phase it is estimated that the total long term disturbance would be 4,649 acres (Table 4.2-G).

The potential effects of habitat loss under any alternative would depend on the location of the development, the types of habitat lost, and the level of bird use in the areas to be developed. Birds that use drier habitats may be more affected by habitat loss than those that use wet habitats because less dry habitat is available in the NPR-A. Loss of dry habitat could be especially important for buff-breasted sandpiper, which is a species of concern with low population numbers that uses dry habitats. The potential impacts of habitat loss to birds would be greater in magnitude under Alternative C because a greater amount of tundra would be covered by gravel placement, and because areas of high bird use north of Teshekpuk Lake that would be closed to leasing and development under Alternative A and Alternative B would be open to development under Alternative C. In addition, compared to the other alternatives, under Alternative C there would be an increased potential for birds to be affected by a functional loss of habitat in areas near roads and pads if development-related disturbances precluded birds from utilizing these habitats. The lease stipulations and ROPs, which would apply under Alternative C as well as the other alternatives, would help to mitigate the potential effects of habitat loss.

Temporary Habitat Loss. Temporary loss of tundra habitat adjacent to gravel roads and pads could occur as a result of thermokarst, dust deposition, snow accumulation, and impoundment formation. Water withdrawal from lakes during ice-road construction could temporarily affect birds in adjacent habitats if the lakes did not have adequate recharge capabilities. Under Alternative C, the types of effects to birds resulting from temporary habitat loss would be the same as those discussed under the other alternatives. Under Alternative C, there would be a greater potential for temporary habitat loss to impact birds than under other alternatives because of the increased size of the development scenario under Alternative C, and because areas of high bird use north of Teshekpuk Lake that would be closed to leasing and development under Alternative A and Alternative B would be open to development under Alternative C. As with permanent habitat loss, the degree of effects would depend on the location of gravel infrastructure and local use of adjacent habitats by bird populations. Lease stipulations and ROPs that would apply under Alternative C would help to mitigate potential effects of habitat loss.

Mortality

Bird mortality could also result from collisions with structures such as elevated pipelines, buildings, drilling rigs, towers, power lines if suspended, boats (including barges), or bridges. The potential for collisions with oil field structures or equipment is discussed under Alternative A. The magnitude of potential impacts to bird populations as a result of collisions in areas of oil and gas development will depend, among other variables, on the location and type of the structure, the species involved, the lighting regime employed and the weather conditions and would likely impact birds at the level of the individual and not at a population level. There would be an increased risk of bird collision with offshore barge and vessel traffic under Alternative C as compared to Alternatives A and B due to an increase in barge traffic necessary for transportation of materials for the greater potential of facilities construction in this alternative due to the greater area open to development. There could also be a greater potential for bird collisions with offshore vessel traffic under Alternative C than under the other alternatives, given the larger area available for development in the Goose Molting Area under Alternative C, which could increase the potential for development and associated vessel traffic in that area. Under Alternative C, ROP E-10 would require illumination to prevent migrating waterfowl from colliding with drilling structures, production facilities, and other structures exceeding 20 feet in height, although the effectiveness of the stipulation is currently unknown. Although there is no similar lighting requirement under Alternative A, the potential risk of bird collisions with oil field infrastructure could still be greater under Alternative C, because the potential benefits of illumination of facilities may not be adequate to mitigate for the presence of facilities within or near areas of high bird use and the potential for greater development in high density bird areas is higher in Alternative C. Under Alternative C, ROP E-11c requires that power and communication lines be buried in roads or suspended on vertical members, to the extent practical and that support wires be clearly marked along their entire length to improve visibility to low flying birds.

Under Alternative C, there may be the potential for greater bird mortality due to predation than under Alternatives A and B if predators were attracted to development in areas of high bird use that are closed to leasing under Alternatives A and B. Alternatives B and C would require the lessee to use the best available technology to prevent facilities from providing nesting, denning, or shelter sites for ravens, raptors, or foxes. Still, it may be difficult to totally exclude ravens from nesting on oil field structures. There would be no equivalent lease stipulation under Alternative A.

Effects of Abandonment and Rehabilitation

The impacts of abandonment and rehabilitation of oil fields on birds would be similar in many respects to those incurred by construction activity. Impact types would be the same for Alternative C as described in Alternative A. Alternative C would likely have a greater impact than Alternative A or Alternative B as more area would be available for oil and gas development in Alternative C, potentially resulting greater total area to be abandoned and subsequently rehabilitated.

Effects of Spills

Oil spills would have similar types of effects to tundra-nesting birds under all alternatives. However, there would be an increased risk of a contaminant spill occurring under Alternative C. The potential for an offshore spill would increase because there would be approximately 40% more barge traffic under Alternative C than Alternative A. Offshore spills would have the

potential to spread through the action of wind and currents, and could affect molting waterfowl along the coastline or in Harrison and Smith bays, as well as shorebirds feeding in littoral habitats of the planning area. The risk of an onshore spill risk increases with increased volume of oil expected to be produced. The risk (or number of) large spills under Alternative C increases by about 40% (slightly less than 1.0 spill – see **section 4.2.2 – Oil Spills)** and the potential spill volume from large spills increases by 4,142 barrels compared to Alternative A.

In the remaining portion of the planning area, the potential for an oil spill to affect birds would be greatest under Alternative C, given that none of the Goose Molting Area would be excluded from oil and gas leasing. Lease Stipulations K-1, K-3, K-4, and K-6, which would provide setbacks from specified rivers, lakes, and the Beaufort Sea coast within which permanent oil and gas facilities would be prohibited, would help to mitigate the potential effects of an oil spill on terrestrial habitats under Alternative C. If a facility was permitted, by the exception process, within the ¼–mile buffer around fish-bearing lakes under Alternative C, there could be a slightly greater potential for an oil spill in the Deep Water Lakes Area to impact waterfowl. Lease Stipulation K-2 would require consultation with regulatory agencies prior to the construction of a permanent facility within the buffer zone. Although Lease Stipulation K-2 was designed specifically to mitigate potential impacts to fish habitat, it may also help protect loons and waterfowl associated with lakes in the Deep Water Lakes Area.

Oil entering a river or stream could potentially spread into delta or coastal areas, where impacts to birds could be more severe. Waterfowl along the shoreline or in marine habitats and shorebirds in the littoral areas of the planning area could be impacted during the fall molting and staging period. Under Alternative C (and alternatives B and D), the potential that an oil spill would enter a major river or stream would potentially be minimized by Lease Stipulation K-1. This lease stipulation would provide setbacks of ½ to 1 mile from specified rivers, within which permanent oil and gas facilities would be prohibited, although pipelines would not necessarily be prohibited in some of these areas. Alternative A has similar lease stipulations.

Commercial Gas Development

The types of impacts on birds that natural gas development and production would cause would be the same as those caused by oil development described above, except that there would be no crude-oil spills and, if a gas pipeline is buried, there would be additional acreage disturbed with increased potential for impacts on bird habitat. Any effects on birds of natural gas development and production under Alternative C that are associated with previously constructed oil infrastructure, such as noise and visual disturbance from vehicles or construction activity, are expected to be temporary, nonlethal, and local, affecting a few individuals. As in the case with Alternatives A and B, resident ptarmigan, gyrfalcons, snowy owls and ravens may be present in the area during construction activities associated with gas development; however, the impacts to these species will be slight, and migrant bird species will not be present during winter construction activities (ADNR, 2006b). Changes in vegetation community caused by burial of the pipeline could result in a loss of bird habitat, and would be more than the other alternatives, because about 12% more habitat would be impacted under this alternative than the other alternatives, reflecting a proportionate increase in the projected length of buried gas pipelines. Any emergency repair of a buried pipeline that occurred in summer has the potential to disturb nesting, brood-rearing, feeding, staging or molting birds. Buried pipelines would not impact birds. Aboveground pipelines could present a collision hazard to low-flying birds.

A natural gas well blowout occurring between May and October could affect birds that are nesting, rearing young, staging, or migrating. Some mortality could result from such an

incident, although it is likely that a small number of individuals would be affected. A gas pipeline leak may also cause effects on birds through the presence of response personnel and equipment. Such impacts to waterfowl would be more likely in Alternative C than the other alternatives because it would make available for leasing and development the largest proportion of the important bird habitat north and east of Teshekpuk Lake.

4.5.8.3 Effectiveness of Stipulations and Required Operating Procedures

Numerous ROPs and lease stipulations were developed for Alternative C to help mitigate impacts to birds and their habitat within the planning area. These include the “A” ROPs, which would help lessen the impacts of that solid, liquid, and hazardous wastes on birds or their habitats, and in reducing the potential for garbage to attract animals that may prey upon birds to exploration and development sites. The “B” ROPs would help lessen the impact of water withdrawals upon lakes or lake habitats, used by molting geese, while the “C” ROPs govern seismic ground operations during spring and summer to help lessen the impact of seismic activity-related disturbance to geese during the nesting and molting periods. Disturbances caused by aircraft are controlled within the Goose Molting Area and raptor sites under ROP “F.” Several of the “K” lease stipulations would be effective in helping to mitigate impacts to birds and their habitats, including habitats associated with rivers and lakes, the Goose Molting Area, and Coastal Area. Lease Stipulation K-4 provides for a number of effective measures designed to reduce the effects of development on molting geese by establishing setbacks from lake shorelines within which construction of permanent oil and gas facilities would not be permitted, regulating water extraction from lakes, and minimizing or eliminating disturbance from aircraft during critical periods. However, this lease stipulation also allows construction of facilities, such as platforms on lakes, if these structures are located more than ¾ mile from the shoreline. Activities at offshore platforms could increase disturbance to molting geese.

4.5.8.4 Conclusion

Under all alternatives, this analysis shows that impacts to birds from non-oil and gas activities would be minor. Alternative C, oil and gas leasing and exploration would be allowed anywhere in the planning area. Lease stipulations and ROPs would provide seasonal and spatial protection to certain environmentally sensitive areas, including Rivers Area, Deep Water Lakes, Goose Molting Area, Teshekpuk Lake Caribou Habitat Area, Pik Dunes, Colville River Special Area, Coastal Area, and Teshekpuk Lake. Effectiveness of lease stipulations are unknown at this time but are presumed to be effective. The exposure of birds to oil and gas activities, and therefore the level of associated impact, would be greater under Alternative C than under Alternative A, given that leasing of lands adjacent to Teshekpuk Lake could occur and that the overall scale of development would likely be greater under Alternative C.

Under Alternative C, the types of disturbances related to vehicle, aircraft, pedestrian, and vessel traffic; routine maintenance activities, heavy equipment use, facility noise, and oil spill clean-up activities would be similar to those described for the other alternatives. In general, impacts to birds from non-oil and gas activities, and from oil and gas activities, would likely be additive, except in those areas where the two types of activities overlapped. Impacts to birds from exploration and development activities would also be additive, except where development activities occurred in areas previously disturbed during exploration. However, once exploration and development/production ceased in an area, bird populations and habitat could recover, reducing overall effects in the planning area. In areas where two or more activities occurred, overall impacts would reflect those impacts associated with the first activity and any new impacts associated with later activities.

Under Alternative C, types of impacts to birds would be similar to those discussed under the other alternatives, but would be greater in frequency and extent because of the high oil and gas potential of the northern portion of the planning area, and the potential for greater development to occur, including in areas currently off-limits to surface development activities. It is expected that impacts to birds in the vicinity of Teshekpuk Lake, and throughout the northern portion of the planning area, would be greater under Alternative C, particularly with respect to molting waterfowl. Overall, impacts throughout the Planning Area would be greater under Alternative C than the other alternatives, given the greater overall scale of the assumed development activities. Impacts to birds from disturbances could be even greater if oil and gas activities occurred in areas with high bird concentrations, with high quality habitat, or used by species of concern. The potential for long term habitat loss and alteration to affect tundra-nesting birds would also be greater under Alternative C, as compared to the other alternatives. Under this alternative, the amount of tundra habitat that would be lost to gravel infrastructure would be greater, and there would be a higher potential for infrastructure to be located in areas of high bird use in the Teshekpuk Lake Special Area. The potential for bird mortality resulting from collisions with vehicles and/or infrastructure and marine vessel traffic, and for an oil spill to impact tundra-nesting birds, would also be greater under Alternative C, as compared to the other alternatives, given the increased amount of infrastructure and development activity. Lease stipulations and ROPs established for Alternative C would help to mitigate potential impacts to tundra-nesting birds.

4.5.8.5 Potential New Mitigation Measures

The potential mitigation measures for Alternatives B through D are essentially the same as those presented for Alternative A in **section 4.3.8.5**. In Alternative A, they are presented as potential new stipulations, consistent with the approach for protective measures in Alternative A. In Alternative B through D, they would be considered as potential new ROPs. They are listed below in their ROP form.

1) Colville River Special Area

<u>**Potential Mitigation Measure (New ROP)**</u>
<u>Objective:</u> Prevent or minimize the loss of nesting habitat for cliff nesting raptors.
<u>Requirement/Standard</u>
a. Removal of sand and/or gravel from cliffs shall be prohibited.
b. Any extraction of sand and/or gravel from an active river or stream channel shall be prohibited unless preceded by a hydrological study that indicates no potential impact by the action to the integrity of the river bluffs.

Potential Benefits and Residual/Unavoidable Impacts

Prohibiting the removal of sand and gravel from cliffs in the Colville River Special Area will enhance existing protections to raptor nest sites in this Special Area. Preservation of cliffs would allow for the continued expansion of the breeding population of cliff nesting raptors in the Colville River Special Area by providing potential nest sites for all species of cliff nesting raptors. Prohibition of removal of sand and/or gravel from an active river or stream channel will negate to potential for subsequent erosion of downstream cliffs. Nest sites for cliff nesting raptors are potentially population limiting and destruction of cliff nest sites caused by sand/gravel mining would accelerate the existing natural erosion of cliffs in the Special Area.

Paleontological resources may indirectly benefit from this measure by providing protection to the substrates that may contain these undiscovered resources. Water quality downstream of a gravel mining operation that occurs in the river bed would benefit from the prohibition of mining in the stream bed and the subsequent erosion of downstream cliffs. Visual resources and recreation would benefit from this measure by virtue of an environment unchanged by human cause gravel mining and subsequent erosion of downstream cliffs.

Construction costs may increase in some situations if gravel needs to be transported to the construction site instead of mining of gravel near the site.

2) Raptor Protection

Potential Mitigation Measure (New ROP)
Objective: Prevent or minimize the loss of raptors due to electrocution by power lines.
Requirement/Standard
Comply with the most up to date suggested practices for raptor protection on power lines. Refer to the publication: Suggested Practices for Avian Protection on Power Lines: The State of the Art in 2006 Item #40-06-01-008 funded and produced by the Avian Power Line Interaction Committee and the California Energy Commission.

Potential Benefits and Residual/Unavoidable Impacts

Requiring all power lines and poles to be designed and constructed in a manner which reflect raptor safe configurations will prevent death of raptors by electrocution.

Additional cost may be incurred by the developer in order to provide raptor safe power lines and poles.

4.5.9 Mammals

4.5.9-a Terrestrial Mammals

4.5.9-a.1 Activities Not Associated With Oil and Gas Exploration and Development

Impacts to terrestrial mammals under Alternative C would be similar to those that would occur under the other alternatives, but could be more frequent, greater in extent, or longer in duration. A greater number of individual animals would be exposed to human activities. Aircraft traffic would more often pass over caribou and other terrestrial mammals during flights to or from the camps and along aerial survey routes. The disturbance reactions of caribou and other terrestrial mammals would likely be brief, lasting for a few minutes to an hour. Some terrestrial mammals might avoid inventory survey and recreation camps during the 6 to 12 weeks of activities, while bears and foxes could be attracted to the camps. Impacts from recreation and overland moves would be the same as under Alternative A. Proposed lease stipulations and ROPs addressing land use authorizations for temporary facilities, overland moves, and recreation permits would effectively mitigate impacts from these activities on terrestrial mammals.

4.5.9-a.2 Oil and Gas Exploration and Development Activities

Under Alternative C, oil and gas leasing and exploration would be allowed throughout the planning area with no exclusions. Lease stipulations and ROPs would be in effect that would provide seasonal and spatial protection to certain environmentally sensitive areas, including Deep Water Lakes, Goose Molting Area, Teshekpuk Lake Caribou Habitat Area, Pik Dunes, Colville River Special Area, Rivers Area, Coastal Area, and Teshekpuk Lake. Terrestrial mammals would be exposed to greater potential impacts under Alternative C compared to the other alternatives, given the leasing of all lands surrounding Teshekpuk Lake with less surface occupancy restrictions than under Alternative D.

Effects of Disturbances

Seismic. Impacts to terrestrial mammals under Alternative C would be nearly the same as those discussed under the other alternatives, since it is assumed that the extent of terrestrial seismic operations would be the same under all alternatives. The only change is that seismic surveys on Teshekpuk Lake itself are considered more likely under Alternative C than in other alternatives, which may cause some disturbance of terrestrial mammals in the vicinity of the lake. It is expected that the reactions of caribou and other terrestrial mammals to disturbance would be brief, although large numbers of wintering TLH caribou could be encountered, depending on the location. Some caribou and other large mammals would likely be displaced from the general area of the seismic work. Some terrestrial mammals would avoid seismic camps, while others, such as foxes, could be attracted to the camps by food odors. The potential for disturbance to hibernating grizzly bears would remain, but bears are present at low density. Muskox and moose would most likely be present in their greatest numbers in the southern portion of the planning area.

The use of airguns for seismic work in Teshekpuk Lake during the summer would likely cause only temporary displacement of terrestrial mammals near the lake. Displacement would occur primarily from the support activity associated with the surveys, such as helicopter flights to bring equipment to the lake. Once surveys were finished and the sources of disturbance had left the area, mammals would likely move back into the area around the lake.

Exploratory Drilling. Under Alternative C, it is projected that up to 120 exploration wells and 90 delineation wells would be drilled. Impacts to terrestrial mammals would be greater in spatial extent, frequency and magnitude than those under the other alternatives, as more exploration would occur, and especially in the area to the north of Teshekpuk Lake which is rated “high” for oil and gas potential and which would be excluded from drilling under Alternative A and Alternative B. Most exploratory drilling would be conducted during the winter when some mammal species are less active or less often present, although wintering TLH caribou could be present in large numbers. Exploratory drilling could also occur during summer from current production pads or platforms within lakes in the TLCH Area. If more exploration activity occurred in the southern portion of the planning area moose, muskoxen, and grizzly bears could experience a greater level of impacts than under the other alternatives.

The implementation of ROPs and lease stipulations should ensure that exploratory drilling impacts to terrestrial mammals are minor. These ROPs and lease stipulations would include provisions to avoid known grizzly bear dens by ½ mile, methods to avoid attracting wildlife to food and garbage, provisions to protect stream banks from damage during overland moves, provisions to minimize the effect of low-lying aircraft on wildlife (particularly over caribou

winter ranges), and provisions to minimize the disturbance and hindrance of caribou in the TLCH Area.

Oil and Gas Development. The entire planning area would be made available for leasing under Alternative C. The primary effects of oil and gas development on terrestrial mammals would be similar to those outlined under Alternative A, and would result from the construction of facilities such as roads and pipelines; motor vehicle traffic within the oil field(s) and on connecting roads; foot traffic near facilities and camps; aircraft traffic; crude-oil and fuel spills contaminating tundra, stream, and coastal habitats; and habitat alteration associated with gravel mining and construction. The greatest potential for impacts to caribou might be through disruption of calving areas and interference in the movement of insect-harassed TLH caribou between insect-relief habitat and foraging areas. These impacts would likely be greater under Alternative C than under the other alternatives, given the larger development scenario that would affect approximately 1379 additional acres of habitat under long-term disturbance as compared to Alternative A and the availability for lease of the high potential lands in the northern portion of the planning area.

<u>Caribou</u>
Although much of the construction associated with oil and gas development would occur primarily during winter, development would bring year-round facilities and activities to caribou range. If a field were developed in the region surrounding Teshekpuk Lake, production pads, pipelines, within-field roads, and other facilities would be located within areas used by the TLH caribou for calving, insect relief, migration, and wintering. A field development in the northern section of the planning area would also require a connector pipeline to link the oil field with facilities to the east.

The types of impacts of field development on caribou would be similar to those outlined under the other alternatives. However, given the greater possibility that a field would be developed within the calving, insect-relief, migration, and wintering grounds of the TLH caribou, impacts to caribou could be substantially greater and more likely under Alternative C, than under the other alternatives. Overall, the level of impact would be dependent on the specific location of any oil field. A field in the central or southern portion of the planning area would not impact the TLH caribou calving grounds, although such a development could still affect the migratory movements of TLH and WAH caribou, and their winter habitat.

Development in the TLH caribou calving grounds could displace some calving animals within 2½ miles of roads (Cameron et al. 1981, 1983, 1992, 2002; Lawhead et al. 1997; Wolf 2000). Movements of some cows and calves across roads would also likely be reduced, and cow caribou might avoid crossing the roads during the calving season. Some TLH caribou movements during the insect-relief season (late June-August 15), including movements to coastal insect-relief habitats, could be affected by pipelines and road traffic, depending on facility placement and design.

Traffic could result in local disturbance and displacement of caribou within one to a few miles of the disturbance. A pipeline linking oil fields in the planning area with facilities at the Alpine and Kuparuk River Unit oil fields would result in the disturbance and displacement of some caribou during winter construction, given vehicle traffic along ice roads and air traffic. It is expected that these disturbances would be short term and occur within about 1 mile of the pipeline corridor. A connecting pipeline between a northern field development and the Alpine and Kuparuk River Unit oil fields could impede caribou migrations.

Construction of permanent roads could increase access to the area for public and subsistence hunting if they were connected to villages or existing road systems. Among ungulate species, caribou would be most affected by increased hunting pressure. However, other species (moose in particular) may also be affected depending on the location of the roads. The overall number of animals taken is unlikely to increase dramatically since most hunting would be for subsistence use, but roads could focus hunts in particular portions of the planning area. Hunting pressure and harvests have increased for many wildlife species near the TAPS since its construction, but have not produced adverse population effects (TAPSO 2001). It is unlikely that the more remote roads associated with oil and gas development in the planning area would have as great an effect on wildlife populations as has occurred along the TAPS corridor.

Moose

Moose occur in low densities in the planning area during the summer and are concentrated in major drainages at the southern edge of the planning area in the winter. Unless an oil field were to be developed in the southern portion of the planning area, development would be unlikely to impact moose. Under Alternative C, impacts to moose would be similar to those that would occur under the other alternatives, because the probability of a development in the southern portion of the planning area would be the same or similar.

If gravel were mined from the southern portion of the planning area, a temporary displacement and disturbance of moose could occur. Borrow pit operations could destroy or degrade about 50 acres of moose habitat for each gravel pit.

Muskox

Muskoxen occur in low densities in the planning area, and they may not be present year-round in all years. Potential effects of oil and gas development activities include displacement and disturbance of individual animals, direct habitat loss from gravel mining in river floodplains and placement at oil field facilities, and indirect habitat loss through reduced access caused by physical or behavioral barriers created by roads, pipelines, and other facilities. Under Alternative C, impacts to muskoxen would be similar to those discussed under the other alternatives, although they could be greater in duration and spatial extent due to the larger overall development scenario. Impacts to muskoxen may be greater if development were to occur in the southern portion of the planning area.

Grizzly Bears

Major sources of noise include construction of roads, installation of pipelines, gravel mining, and drilling operations. These activities could disturb grizzly bears within a few miles of the noise sources. Industrial activities and human presence could also cause potentially serious disturbances to denning bears. Under Alternative C, impacts would be similar to those that would occur under the other alternatives, although the extent and duration of the impacts could be greater because of the larger overall development scenario, depending on the location of the field development. Grizzly bears are present in low numbers in the northern portion of the planning area, but may be attracted to development activities. It is likely that the greatest number of bears would be encountered during development in the southern portion of the planning area, since the greatest amount of suitable habitat is located in this area.

Wolves

Under Alternative C, oil and gas development would have a minimal impact on wolves, similar to Alternative A and Alternative B, but could be greater than the impact that would occur under these. Potential effects on wolves would include short-term disturbance from air and surface traffic and human presence, and increased hunting and trapping pressure through improved

access or increased human presence associated with oil development. If caribou abundance were negatively affected by oil and gas development, wolf abundance could in turn be affected. However, wolves are generally not abundant in the planning area.

Wolverines
Similar to the other alternatives, under Alternative C some wolverines could be displaced in the vicinity of oil field facilities. Impacts under this alternative are likely to be greater than those that would occur under the other alternatives, given the larger overall amount and extent of potential development in the planning area.

Foxes
Under Alternative C, impacts to foxes would be similar to those discussed under the other alternatives, although they could be greater in duration and extent. An increase in the fox population associated with oil development, which could likely be greatest under Alternative C, could affect some fox-prey species (such as ground-nesting birds and molting waterfowl) in the development area and over a region larger than the oil field itself (Burgess et al. 1993).

Other Mammals
Small rodents and their predators would be affected locally (i.e., through direct mortality of individuals or small groups of lemmings and voles, or through loss of habitat) along pipelines, gravel pads, and other facilities. Arctic ground squirrels sometimes den in gravel fill in the oil fields (Shideler and Hechtel 2000). The availability of suitable burrowing habitat could increase local densities of ground squirrels. Under Alternative C, impacts would be slightly greater than those that would occur under the other alternatives, given the larger overall scale of the development scenario.

Effects of Abandonment and Rehabilitation

Abandonment and rehabilitation activities are expected to disturb and displace terrestrial mammals in a manner similar to that associated with construction. The intensity of the disturbance might be less than during construction, however, because it is possible that caribou, muskoxen, and other terrestrial mammals would have become habituated to road and air traffic over the course of construction and operation of the facilities. Some individuals could be killed by collisions with road traffic. If roads were left in place and maintained in useable condition upon abandonment, they could continue to provide improved access to hunting areas, with consequent hunting pressure on caribou and other subsistence species. Revegetation of the roads, pads, and the airstrip left in place would facilitate rehabilitation of habitat, but plant communities on these raised gravel structures would likely be different from those that prevail in adjacent areas and may include invasive species. However, pads, roads, and airstrips, if left in place, could provide some insect-relief habitat for caribou (Murphy and Lawhead 2000). If gravel fill was removed and the pad revegetated with vegetation similar to the surrounding plant communities, caribou, and possibly other terrestrial mammals, would use the area. Foam insulating materials that could be used in pad construction could be broken up in the course of removal. If some of this foam escapes being cleaned up, it may be used by foxes as denning material. Depending on the material's toxicity and the amount ingested by a fox, this could cause mortality, though the numbers of foxes killed would likely be very small. Overall, a greater amount of development is assumed under Alternative C than under Alternatives A or B, providing a potential of greater impacts from abandonment and rehabilitation. However, they would likely be expressed over a longer time period resulting in no population level effects from these activities in either case.

Effects of Spills

Typical refined products that are spilled on the Alaska North Slope include aviation fuel, diesel fuel, engine oil, fuel oil, gasoline, grease, hydraulic oil, transformer oil, and transmission oil. The extent of environmental impacts would depend upon the type and amount of material spilled, the location of the spill, and the effectiveness of the response. The majority of small spills would be contained on the gravel pad and would have no impact on terrestrial mammals or their habitat.

The impacts of oil spills on terrestrial mammals are described under Alternative A (**section 4.3.9, *Mammals***). Compared to the other three alternatives, the risk of oil spills could be greater under Alternative C, given the greater extent of development and the subsequently higher estimate of spills. Activities occurring in the vicinity of Teshekpuk Lake could increase the likelihood that a spill would reach the lake under Alternative C. Because most spills would be small and affect a small area, the majority of impacts to terrestrial mammals would likely result from disturbance associated with spill clean-up activities, rather than from direct oiling.

Commercial Gas Development

The types of impacts from gas development under Alternative C would be similar to, but greater in magnitude, than the other alternative, both because under Alternative C more important caribou calving and insect relief area is made available for leasing than in any other alternative and because under this alternative the projection is for approximately 12% more miles of gas pipelines. As described for the other alternatives, buried pipelines would have no impact on caribou movement, though disturbance could occur during winter construction in approximately the same way as it would occur by construction of aboveground pipeline. The noise associated with a 10- to 20-acre compressor station may cause avoidance, but the pad's raised surface may attract caribou seeking insect relief.

If a gas pipeline was elevated on a set of VSMs separate from oil-pipeline bearing VSMs, caribou movement could be hindered.

Construction and operation of gas facilities would likely impact other terrestrial mammals in a manner similar to and in like proportion, when comparing among alternatives, to the impacts associated with oil development.

In the event of a natural gas well blowout or pipeline rupture, would be similar to that described for the other alternatives. Terrestrial mammals in the immediate vicinity of the blowout could be killed. Given the small area that would be exposed to the plume and the rapid dissipation of the gas, it is not likely that any animals other than individuals present in the immediate vicinity at the time of the blowout would be affected. The likelihood of caribou, moose, muskoxen, wolves, or grizzly bears being exposed to toxic amounts of gas and condensates is very low and (should it occur) would probably only affect a few individuals. Smaller, less mobile species with small home ranges, such as squirrels, voles, and lemmings may be affected in larger numbers. However, there would be no population level impacts on any species.

4.5.9-a.3 Effectiveness of Stipulations and Required Operating Procedures

Alternative C would include the same lease stipulations and ROPs that were outlined under Alternative B (**section 4.4.9.1, *Terrestrial Mammals***), and they would provide similar protection to terrestrial mammals as those developed for Alternative B.

4.5.9-a.4 Conclusion

Under Alternative C, impacts to terrestrial mammals would be similar to those discussed under the other alternatives, but would be greater in frequency and extent because of the high oil and gas potential of the northern portion of the planning area, and the potential for greater development to occur, including in areas currently off-limits to surface development activities.

Impacts expected under Alternative C would be greater than those under the other alternatives, given that all of the area north of Teshekpuk Lake would be available for development, except those areas protected by lease stipulations and ROPs. There would be an increase in the likelihood of impacts to calving areas and migration routes leading to insect-relief habitat, as well as an increased likelihood of development occurring within insect-relief habitat.

It is expected that impacts to terrestrial mammals in the vicinity of Teshekpuk Lake, and throughout the northern portion of the planning area, would be greater under Alternative C, particularly with respect to caribou calving and insect-relief habitat. Overall, impacts throughout the planning area would be greater under Alternative C than the other alternatives, given the greater overall scale of the assumed development activities. In general, impacts to mammals from non-oil and gas activities, and from oil and gas activities, would likely be additive, except possibly in those areas where both types of activities occurred. Impacts to mammals from exploration and development activities would also be additive, except possibly for habitat impacts where development occurred in habitats previously disturbed during exploration. In areas where two or more activities occurred, overall impacts would reflect those impacts associated with the first activity and any new impacts associated with later activities. Based on the amount of habitat with a potential to be affected, the potential for impacts to mammals under this alternative would be about 40% more than Alternative A. If oil and gas activities occurred in areas with an abundance of caribou or other mammals, or in areas with high quality habitat, impacts could be greater than those based strictly on number of acres of habitat impacted.

4.5.9-b Marine Mammals

4.5.9-b.1 Activities Not Associated With Oil and Gas Exploration and Development

Under Alternative C, impacts associated with non-oil and gas activities would be similar to those described under the Alternative A and Alternative B. Overland moves could disturb a few ringed seals if overland moves were to occur over floating, shore-fast ice. It is expected that small fuel spills would occur, but they would be small, and primarily terrestrial and unlikely to reach areas used by marine mammals.

Small fuel spills could occur under Alternative C. However, these small spills would not be expected to negatively impact marine mammal populations in or near the planning area. Under Alternative C, it is expected that the effects of non-oil and gas activities on marine mammals would be localized and short term with no or minor effects to marine mammal populations.

4.5.9-b.2 Oil and Gas Exploration and Development Activities

Effects of Disturbances

The frequency, spatial extent, and magnitude (intensity and duration) of the impacts likely will vary among alternatives in relation to the total amount of area open to development, the location of the areas open, and the Lease Stipulation and Required Operating Procedures. Alternative C makes entire planning area open to exploration and development, although special restrictions under Lease Stipulation K-4 still apply within ¾ mile from the coast line. The Alternative C development scenario estimates approximately 42% (1380 acres) more permanent disturbance than Alternative A and 25% (933 acres) more permanent disturbance than Alternative B. The increase in potential adverse effects is expected to be proportional to those difference between alternatives. With regards to marine mammals it is primarily the indirect effects of greater development–primarily vessel traffic–under Alternative C that separates its impact potential from the other Alternatives. Like Alternative B, opening the area north of Teshekpuk Lake creates a greater potential for adverse impacts to marine mammals compared to Alternative A although special restrictions under Lease Stipulation K-4 still apply within ¾ mile from the coast line.

Seismic

Seismic exploration is expected to have the same potential for affect and likelihood to occur as under Alternative A. However, the ¾ mile coastal buffer required by ROP K-4 would reduce the attractiveness of the Atigaru/Kogru area making the likelihood of seismic in these areas lower than under Alternative A. The low likelihood of seismic under this alternative combined with the expected very low density of seals in these shallow areas (Moulton et al. 2005) makes it unlikely that seals would be affected by seismic work. No effect to whales is anticipated.

Visual and Noise Disturbance

Aircraft

The effects of aircraft disturbance would be similar to those described under the previous Alternatives, but could be greater in extent, given the greater number of pads and production facilities expected under Alternative C. More importantly, because development would be allowed north of Teshekpuk Lake the number of aircraft that would regularly occur over areas that may be used by marine mammals would increase. However aircraft would generally fly at 1,000 feet AGL over water, minimizing the potential for disturbance to seals and most likely whales (Born et al. 1999, Patenaude et al. 2002, Richardson and Williams 2004, Moulton et al. 2005).

Shipping

Under the development scenario for Alternative C, the projected levels of development and related activities could be affect 42% more area than under the Alternative A and 20% more than Alternative B. The greater level of estimated development could result in a greater potential for disturbance to marine mammals from increased barge traffic used to transport supplies and modules for development. It is expected that the difference in impacts from shipping among alternatives is proportional to the difference in number of vessel trips. Seven to 14 sealifts, 1-2 every 10 years, would be required to support development of the estimated CPFs, totaling 210 to 420 barges over a period of approximately 70 years (approximately 40% more

than estimated for Alternative A). It is assumed that development operations in the planning area would be staged out of the Prudhoe Bay or the Kuparuk River Unit facilities, with no dock or causeway constructed along the planning area coast. Materials and equipment would likely be moved to staging areas in the planning area using trucks over ice roads in the winter months. Under this scenario, increased summer barge traffic could result in more (20% more than under Alternative B; 40% more under Alternative A) disturbance and displacement to whales and seals, and local and short-term changes in marine mammal behavior, as barges and sealifts passed along the coast. However, it is possible that barges could be landed on the northern coast of the planning area, most likely at Lonely. In this scenario, increased barge traffic during the summer could result in more disturbance and displacement of whales and seals than under Alternative A because barges would be maneuvering off the coast and be in place for several days instead of transiting past. Although like Alternative A and B the displacement/disturbance is expected to be localized in time (only occur within a short distance <1 mile for seals, 1-4 miles for whales) in time and short-term (hours or days). It is not expected that effects would levels that could result in substantial impacts to individual marine mammals or populations, although the fitness of some individuals could be impacted.

Contaminants

The effects of a spill on marine mammals would be as described under the Alternative B. The likelihood of a spill reaching or occurring in areas used by marine mammals is higher due to the greater amount of development but is still very low. Although a greater area is open, Lease Stipulation K-4 places a ¾ mile buffer along the entire coastline, including the area around Atigaru Point, which is open under Alternative A.

Collisions

The likelihood of a vessel strike is influenced by the number of vessels traveling through an area over time. Speed probably has an influence on the likelihood of a collision and does increase the potential that a collision will result in sever injury or death (Laist et al. 2001). Alternative C would result in an estimated 20%-40% more vessel traffic than Alternative B and A respectively with a commiserate increase in the likelihood of a collision. Given the expected low rates of collisions (George et al. 1994), this change while moderate in percentage terms is likely a minor risk in actual number of animals injured or killed.

Effects of Abandonment and Rehabilitation

Impacts of abandonment and rehabilitation activities are expected to be similar to those for construction. Given the expense of transport vessel traffic is expected to be substantially lower than occurred during construction as large modules or other equipment may be moved to other development or stored at regional staging areas rather than moving it off the North Slope. The potential for impacts is expected to be proportionally greater compared to Alternative A and B.

4.5.9-b.3 Effectiveness of Stipulations and Required Operating Procedures

Alternative C includes the same lease stipulations and ROPs as outlined under Alternative B. These ROPs and lease stipulations should provide similar levels of protection as those developed for the Alternative A.

4.5.9-b.4 Conclusion

Under Alternative C, the effects of non-oil and gas activities on marine mammals, particularly ringed seals along the coast of the planning area, would be short term and localized, occurring within one mile of aircraft corridors, survey activities, recreational camps, and overland moves.

Oil and gas leasing and development activities would likely result in a greater level of noise and disturbance, primarily near the Colville River Delta and inner Harrison Bay, than under the other alternatives because of the greater level of development. Effects should be localized (within 1 mile of aircraft corridors and activities) and short term as individual sealifts would typically be completed in one season. Lease Stipulation K-6 would minimize the potential for development to impact ringed seals, spotted seals, and beluga whales in areas along the coast. While exploration could occur in this area under Alternative C, surface occupancy would generally not be allowed. The effects of seismic exploration would be limited to short-term, localized disturbance to denning or hauled out ringed seals. The effects of development under Alternative C are expected to be short term, with few effects on marine mammal populations.

A small number of ringed seals, spotted seals, beluga whales, and possibly harbour porpoise could be affected by oil spills entering the Kogru River, the Colville River, or drainages that empty into the Colville River, Fish Creek, or Judy Creek. The likelihood of such and event is small and not expected to occur. It is expected that any losses would be small.

The effects of development under Alternative C are expected to be greater than those under the Alternative A and B due to the greater amount of exploration and development projected to occur under this alternative. However, these effects would be short term, with few impacts on marine mammals and no detectable impact on populations. Since nearly all exploration and development activity would occur onshore under all alternatives, the potential for impacts to marine mammal resources under Alternative C would be slightly greater than those that could occur under the Alternative B and moderately greater than those under Alternative A.

4.5.10 Threatened and Endangered Species

This section discusses the potential effects to bowhead whale, spectacled and Steller's eiders, and polar bear which could result from management action in the planning area under Alternative C. Whales would be most affected by disturbance and oil spills. Most, but not all, activities that could potentially affect eiders and polar bears in the planning area would be associated with oil and gas exploration and development. Other activities that could occur in the planning area include subsistence hunting, recreational use, and activities associated with scientific survey and research camps.

4.5.10-a Bowhead Whales

4.5.10-a.1 Activities Not Associated With Oil and Gas Exploration and Development

Under Alternative C, the effects of non-oil and gas activities on bowhead whale would be similar to those that would occur under Alternative A, and would occur only when bowhead whales migrated exceptionally close to shore. It is not expected that non-oil and gas activities would have high impacts on individual bowhead whales or the population.

4.5.10-a.2 Oil and Gas Exploration and Development Activities

Effects of Disturbances

The effects of oil and gas activities on bowhead whale would be similar in type but of greater magnitude under Alternative C than under Alternative A, given the greater area that is available for development. There would be an approximately 40% and 20% increase in barge traffic compared to Alternatives A and B, respectively, and a greater likelihood that barges would come ashore and be unloaded along the coast of the planning area. Because the areas north of Teshekpuk Lake would be open and development could potentially occur there, a greater likelihood that regular aircraft operation over marine waters would occur is also expected. As discussed under Alternative A the effects of those activities are expected to be limited to short-term avoidance behavior, but more studies are required to assess consequences of eliciting this behavior. It is unknown if the potential increase in these disturbance activities would result in an impact level that significantly reduces the fitness of individual bowhead whales, although it is unlikely that population level effects would be detected.

Contaminants

There would be a greater potential for oil spills under Alternative C than under Alternative A or B, given the larger area available for development and higher levels of development activity that would occur under Alternative C. However, it would still be unlikely that spilled oil would reach bowhead whale habitat. The potential for an accidental release of contaminants from barge traffic would increase slightly due to the estimated increase in number of barges but this remains an unlikely event (although the probability of a spill occurring would increase as a result of a 40% increase in barge traffic compared to Alternative A).

The southward edge of the migration corridor could be deflected northward due to any vessel activity associated with containment and clean-up activities occurring during the fall migration. However, impacts to individual bowhead whales or the whale population would be minor, except in the case of a very large spill coincident with the fall migration, which is very unlikely.

Collisions

Alternative C is estimated to result in an approximate 40% increase in barge traffic over Alternative A. The projected increase in barge traffic would not all occur in one year but would consist of more sealifts than Alternative A or B spread over some period of time, likely separated by 10 years. The likelihood of a vessel strike is influenced by the number of vessels traveling through an area over time thus the likelihood of a collision is increased under Alternative C compared to Alternative A and B. However, given the expected low rates of collisions observed in the past (George et al. 1994), those expected based on the low rate of speed barges typically travel (Laist et al. 2001), and that barges usually are active only during the earlier portion of migration, this change, while moderate in percentage terms is likely a minor risk in actual number of whales injured or killed.

Effects of Abandonment and Rehabilitation

Impacts of abandonment and rehabilitation activities are expected to be similar to those for construction and higher than under Alternative A and Alternative B. Effects could occur from aircraft, barges used to transport equipment to remove materials from the planning area, and potential spills.

Commercial Gas Development

If natural gas development and production occur in the planning area, it is unlikely that bowhead whales would be affected other than temporary, nonlethal effects from marine vessels as described for traffic associated with oil development.

4.5.10-a.3 Effectiveness of Stipulations and Required Operating Procedures

There are no Stipulations or Required Operating Procedures specific to bowhead whales, but several would indirectly reduce the potential that any oil spill would reach marine waters. Lease stipulationK-1 requires no development setbacks from the banks of major rivers in the planning area. While this stipulation does not prohibit pipelines from crossing rivers, development would be prohibited from within ½ to 3 miles from the banks. This should substantially reduce the potential for a large spill originating from pads or pipelines parallel to the river channel to reach the river and be transported from to marine waters. Lease Stipulation K-4 requires a ¾ mile set back from the coast which would have a similar effect as K-1, reducing the potential for a large spill to reach marine waters.

4.5.10-a.4 Conclusion

Alternative C is expected to result in approximate 42% more surface disturbance than Alternative A and 25% more than Alternative B; potentially distributed over a greater area of the Planning Area than either Alternative A or B, with a commiserate increase in barge traffic, aircraft, and spill potential. Therefore there is a greater likelihood of impacts to bowhead whales, including behavioral displacement from high density foraging areas, injury, and mortality from ships and oil spills. However, displacements are expected to be short-term and spills unlikely and should they occur a relatively small proportion of the population is projected to be affected by these impacts. In those years where bowheads occur in shallower waters during fall migration the number affected could be higher, but potential effects are not expected to be severe enough to lead to changes in the population unless a very large oil spill occurred in the marine environment.

4.5.10-b Spectacled and Steller's Eiders

4.5.10-b.1 Activities Not Associated with Oil and Gas Exploration and Development

Non-oil and gas activities that could affect spectacled and Steller's eiders under Alternative C would be the same as those listed under the other alternatives—private or commercial air traffic, aerial surveys to inventory wildlife or other resources, summer research camps, hazardous material or debris removal, subsistence hunting and fishing, and recreational camps and boating activity. Under Alternative C, a larger area would be available for permanent oil and gas facilities and development than under the other alternatives. However, the potential for non-oil and gas activities to disturb, displace, or cause mortality would likely be similar under all four alternatives. Lease stipulations and ROPs would mitigate some of the potential effects of non-oil and gas activities.

4.5.10-b.2 Oil and Gas Exploration and Development Activities

Seismic

The effects of seismic exploration on eiders is expected to be the same as under Alternative A as similar levels of seismic exploration are predicted for all alternatives (**section 4.2.1.2**). Although as with Alternative B seismic could be conducted on Teshekpuk Lake it would be done over-ice – if at all as seismic is projected to be infill in areas not already explored.

Exploration

Under Alternative C, the potential effects of ice-road and ice-pad construction would be greater than to those described under Alternative A and Alternative B, and would involve the temporary alteration of tundra vegetation, because a larger area would be available to oil and gas exploration activities under Alternative C than under Alternative A or B. Thus, the associated impacts to eiders could also potentially be greater under Alternative C.

Predators, such as glaucous gulls and Arctic foxes, could be attracted to anthropogenic food sources associated with summer maintenance of exploratory drilling and seismic equipment or winter exploratory activities. As with the other Alternatives with the performance-based ROPs and Lease Stipulations the potential for increased predation of eiders by predators attracted to development would be reduced by ROP A-2, A, although the relatively greater amount of exploration drilling would increase the likelihood of predator attraction under Alternative C. The typical short time period and seasonality of exploration would reduce the likelihood that predators would discover any human provided food source as well as reducing the likelihood of predators persisting in the area because there would be no recurring anthropogenic food source. Furthermore, since exploration is primarily a winter activity, avian nest predators would not be present, except for possibly common ravens.

Development and Production

Activities related to oil development and production in the planning area, such as vehicle, aircraft, pedestrian, and boat traffic, routine maintenance activities, use of heavy equipment, oil-spill clean-up activities, and aerial surveys to inventory wildlife or other resources, could cause disturbances that would affect eiders. Under Alternative C, the types of disturbances to eiders would be the same as those discussed for the other Alternatives. These disturbances could result in temporary displacement from preferred foraging, nesting, or brood-rearing habitats, decreased nest attendance or nest abandonment, and increased energy expenditures that could affect physiological condition and rate of survival or reproduction. The likelihood for impacts to eiders would depend on the location of the disturbance, the number of eiders in the area, and the time of year. Under Alternative C, these impacts would likely be greater than those compared to the other alternatives because of the greater area that is available for development.

The potential for disturbance to threatened eiders from activities on roads and pads would likely be greater under Alternative C, as compared to Alternative A or B, because areas that support relatively high spectacled eider concentrations would be available for oil and gas leasing under Alternative C, but not under Alternative A and only a small portion under Alternative B.

Lease Stipulation K-5, designed to protect the Teshekpuk Lake Caribou Habitat Area, would reduce disturbance effects to eiders by placing limits on various types of activities on roads and pads between May 20 and August 20.

As with Alternative B, Alternative C could also result in a greater level of disturbance to eiders in the Deep Water Lakes Area south of Teshekpuk Lake, than under Alternative A. Under Alternative A, no permanent oil and gas facilities would be permitted within ¼ mile of the any fish-bearing lake. Under Alternative B and C, facilities would generally not be permitted within this buffer, but could be permitted, on a case by case basis, in consultation with Federal, state, and NSB regulatory and resource agencies. Permitting facilities within the ¼-mile buffer of fish bearing lakes in the Deep Water Lakes Area could result in disturbance to eiders near the facilities and access roads. Although Lease Stipulation K-2 has been designed primarily to provide mitigation for deep-water fish habitat, it could also provide protection for eiders using habitats near these lakes.

Air Traffic. The types of effects to eiders from aircraft would be the same as under other Alternatives and could include displacement from preferred feeding habitats, temporary or permanent nest abandonment, and temporary or permanent displacement from molting or brood-rearing areas. However, some eiders could either remain in habitats located near aircraft activities or move to nearby habitats. Although there is evidence that molting and staging geese are disturbed by aircraft (Jensen 1990, Ward et al. 1999)and pre-nesting eiders may respond to low flying (≤ 150 feet) aircraft (Balogh 1997). Evidence of adverse impacts to eiders is equivocal. Johnson et al (2006) found no indication that spectacled eider nests with higher levels of overflights had reduced nest success compared to those with no or less overflights. However, their dataset is short-term and it is reasonable to assume that some level of effect may occur under certain circumstances. Repeated flushing of pre-nesting birds may reduce nesting success, more sensitive birds may not nest or be displaced to lower quality nesting habitat, and disturbance of molting eiders may result in greater rates of predation and reduced fitness with subsequent reduced migratory survival. None of these effects have been demonstrated, and would be very difficult to establish cause and effect relationships; however, here it is assumed that they are possible, but the magnitude (number of birds affected) and severity (likelihood of mortality/reduced recruitment) is unknown.

A greater number of eiders could be affected by air traffic under Alternative C than A or B. Even though a larger area would be available for oil and gas leasing, and facilities could be located in areas where surface activity was prohibited under Alternative A and to a lesser extent restricted or prohibited under Alternative B, Lease Stipulations K-3 through K-6 would provide setbacks from various habitats surrounding Teshekpuk Lake and along the coast that are considered important for fish, birds, and caribou in the area. Within these setbacks, permanent oil and gas facilities would be prohibited, and other potentially disturbing activities, such as vehicular and air traffic, would be restricted. These lease stipulations would help to reduce potential aircraft disturbance to eiders, should oil and gas facilities be located within portions of the Teshekpuk Lake Special Area. However, if CPFs were located within the Teshekpuk Lake Special Area, the level of aircraft disturbance would likely increase along flight corridors and near airstrips located at these CPFs. Flight restrictions under Lease Stipulations K-4 and K-5 would be expected to also reduce the effects of aircraft in the Caribou Habitat Area/Goose Molting area.

Watercraft. Several types of watercraft could be used during the summer to transport equipment and supplies, to conduct oil spill response training drills. Summer barge traffic with the potential to temporarily displace molting eiders could occur in offshore waters of the

planning area from mid-July through October. How eiders will react to boat traffic is unknown but the may react similarly to other waterfowl with short-term short-distance avoidance movements (Flint et al. 2003). Displaced eiders would probably move to adjacent habitats or return to original habitats after the barges passed though the area and barge traffic would not be expected to substantially impact molting eiders. There would be a greater likelihood for disturbance to molting eiders under Alternative C than under Alternative A because much of the area adjacent to the coast would be open for leasing under Alternative C but unavailable for oil and gas development under Alternative A. Therefore, it would be more likely that development would occur in portions of the Goose Molting Area, and that barge traffic would be required near this area for transportation of equipment and supplies during oil field construction and operation.

Oil spill response training activities using watercraft could be conducted on rivers and lakes several times during the summer open-water season. Under Alternative C, these activities would be more likely to disturb eiders than under Alternative A, because there would be a greater likelihood that facilities would be located in areas of spectacled eider concentrations within the Goose Molting Area.

Habitat Loss and Alteration

Under the development scenario for Alternative C the gravel footprint for roads, pads, airstrips, staging areas and gravel extraction sites is estimated to be approximately 4649 acres; approximately 42% more than under Alternative A and 25% more than Alternative B. Loss of eider habitat would be permanent in the area occupied by the development footprint, and eiders nesting in this area would be displaced to other areas. Their survival and future reproductive success would be dependent on the availability and quality of unoccupied habitat.

If spectacled and Steller's eider densities are assumed to be 2.0 and 0.02 birds per mi^2 (640 acres per mi^2) respectively (very high estimates based on aerial survey data; Larned et al. 2006; Ritchie and King 2003), up to 14.6 spectacled eiders and 0.2 Steller's eider could be expected to be displaced by the gravel footprint over the life of the plan if all development occurred in high density areas. This estimate is likely overly-conservative as areas of "high high" density make up only a small proportion of the planning area even with the entire area north of Teshekpuk Lake being open under Alternative C (Map 3-33.).

Alternative C would open the entire area north of Teshekpuk Lake. Average eider density over 15 years in area north of Teshekpuk Lake is 0.79/mi^2. This area also contains approximately 57% of the indicated population within the Northeast NPR-A planning area (FWS, unpublished data). When this area is included, the average Northeast NPR-A spectacled eider density is 0.36 eiders/mi^2. For comparison average spectacled eider density in the entire Eider Breeding Survey Area is 0.57 eiders/mi^2 (Larned et al 2006). Steller's eider densities are so low that estimates are not calculated from the Eider Breeding Survey (Larned et al. 2006)

However, under all alternatives, the potential effects of habitat loss would depend on the location of the development, the types of habitat lost, and the level of eider use in the areas to be developed. Without specific information on the locations of potential developments, the estimates of eiders potentially impacted should be seen as an index of comparison between alternatives, not an absolute value of birds affected.

In addition to permanent habitat loss, temporary loss of tundra habitat adjacent to gravel roads and pads could occur as a result of thermokarst, dust deposition, snow accumulation, and

impoundment formation. Under Alternative C, the types of effects to eiders resulting from temporary habitat loss would be the same as those discussed under Alternative A. As with permanent habitat loss, the degree of effects would depend on the location of gravel infrastructure and local use of adjacent habitats by eiders. However, impacts from the temporary loss of habitat is projected to be greater under Alternative C than the other alternatives because more areas with higher densities of eiders are available of oil and gas leasing. Lease stipulations and ROPs would help to mitigate potential effects of habitat loss to eiders.

Mortality

Compared to the other alternatives, there would be an increased risk that eiders would collide with offshore barge and vessel traffic under Alternative C compared to the other alternatives, as more area would be available for development north and east of Teshekpuk Lake that could increase the potential for development in that area and the amount of associated vessel traffic in offshore areas. Drill rigs and other tall structures would be present for a longer period of time and would increase the potential for collisions over other alternatives. Given that the highest concentrations of spectacled eiders in the planning area occur in this area, the siting of facilities within this area would increase the potential for eider mortality due to collisions with oil field structures or equipment, relative to other alternatives.

There would also be an increased risk of eider collisions with vehicles under Alternative C compared to the other alternatives because of the potential for road construction in the Goose Molting Area. The overall risk of eider collision with development related facilities or equipment would be greater under Alternative D compared other alternatives.

Some predators, such as ravens, gulls, Arctic fox, and bears may be attracted to areas of human activity where they find anthropogenic sources of food and denning or nesting sites. The potential impacts of increased levels of predation on eiders resulting from increased numbers of predators that may be attracted to developed areas are discussed under Alternative A. The potential types of effects of increased predation to eiders under Alternative C would be the same as those discussed under Alternative A. Under Alternative C, the impacts to eiders from predation are expected to be greater compared to impacts from Alternatives A and B.

Effects of Abandonment and Rehabilitation

Winter activities would cause little disturbance or displacement, because eiders are absent from the area during the winter. However, ice roads could impound water and reduce habitat for nesting birds; such impacts would only affect nesting in the summer following ice road use. These impacts should be very minor, however, since most ice roads have melted prior to the time of nest initiation. Summer road and air traffic generated by abandonment and rehabilitation activities could cause disturbance, displacement, and mortality to eiders similar to, and at the same levels as, those described for traffic during construction and operations. If pads, roads, and airstrips were not revegetated, impacts to eider habitat would be permanent. If they were revegetated without removing the gravel, the habitat would not return to its historic use. If gravel was removed, habitat similar to that existing in the area could be created and used by eiders, although the habitat types would likely not be the same as what occurred in the area prior to disturbance. It is expected disturbance impacts to eiders from abandonment and rehabilitation of oil and gas facilities and supporting infrastructure would be greater under Alternative C than Alternatives A and B.

Effects of Spills

Oil spills would have similar types of effects to eiders under all alternatives. However, there would be an increased risk of a contaminant spill occurring under Alternative C. The potential for an offshore spill would increase because there would be approximately 40% more barge traffic under Alternative C than Alternative A. The risk of an onshore spill risk increases with increased volume of oil expected to be produced. The risk (or number of) large spills under Alternative C increases by about 40% (slightly less than 1.0 spill – see **section 4.2.2 – Oil Spills)** and the potential spill volume from large spills increases by 4,142 barrels compared to Alternative A. An offshore spill would have the potential to spread through the action of wind and currents and could affect molting eiders in Harrison and Smith bays.

There could be an increased risk that an oil spill would occur and impact eiders in onshore habitats north and east of Teshekpuk under Alternative C, as compared to the other alternatives, as more of this area would be available for leasing under Alternative C. In the remaining portion of the planning area, the potential effects of an oil spill to eiders would be similar under all alternatives, although densities of eiders are lower than north of Teshekpuk Lake. Excluding the Goose Molting Habitat Area and Teshekpuk Lake Special Area, the areas available for leasing would be the same under all alternatives, and similar lease stipulations would apply. There would be a greater potential that an oil spill would occur and impact eiders in the Deep Water Lakes Area south of Teshekpuk Lake under the Alternatives B, C and D than Alternative A, as a facility could be permitted within the ¼-mile buffer around fish-bearing lakes under the action alternatives. However, Lease Stipulation K-2, which would apply to the Alternatives B, C, and D would prohibit permanent facilities within ¼ mile of fish-bearing lakes without prior consultation with regulatory agencies.

Oil entering a river or stream could potentially spread into delta or coastal areas where impacts to threatened eiders could be more severe. Lease Stipulation K-1 would help reduce the likelihood that an oil spill would enter a major river or stream. This lease stipulation would provide setbacks of ½ to 3 miles from specified rivers, within which permanent oil and gas facilities would be prohibited, although pipelines could be permitted in some of these areas.

Commercial Gas Development

Gas development would have impacts on eiders similar to that described for oil development, except that there would be no impacts from oil spills. Any effects of natural gas development and production on spectacled and Steller's eiders are expected to be limited to temporary, nonlethal effects, perhaps resulting in disturbance to a few birds. However, a natural gas well blowout occurring from June to September could affect eiders that are nesting, rearing young, staging, or migrating. Some mortality could result from such an incident, although it is likely that no more than a small number of individuals would be affected. Such impacts to eiders would be most likely in Alternative C, which make more important eider habitat available for leasing north and east of Teshekpuk Lake than any other alternative.

4.5.10-b.3 Effectiveness of Stipulations and Required Operating Procedures

Lease stipulations and ROPs would help prevent spilled fuel, oil, or other toxic materials from reaching the marine environment, thereby minimizing the potential for effects to molting or staging eiders. These measures would also protect habitat and help to minimize disturbance to eiders from oil and gas exploration and development activities. These measures should be equally, or more effective than the measures developed for Alternative A.

Numerous lease stipulations and ROPs were developed to mitigate impacts to birds and their habitat within the planning area. These include the "A" ROPs, which would be effective in ensuring that solid, liquid, and hazardous wastes did not impact birds or their habitats, and in reducing the potential for garbage to attract animals that may prey upon birds to exploration and development sites. The "B" ROPs would be effective in ensuring that water withdrawals do not impact lakes, or lake habitats, used by molting geese or threatened eiders, while the "C" ROPs govern seismic ground operations during spring and summer to prevent seismic activity-related disturbance to eiders during the nesting and molting periods. Disturbances caused by aircraft are controlled within the Goose Molting Area and raptor sites under ROP F and K-4 and K-5. Several of the "K" lease stipulations would help lessen impacts to eiders and their habitats by placing buffers around rivers and lakes ranging from ¼ mile around lake shores in the Goose Molting Area and deep water lakes (Stipulation K-4 and K-2 respectively) to1/2 mile to 3 miles around major rivers (Stipulation K-1).

However, only ROP E-11 is specific to eiders. It requires pre-construction surveys for 3 years which will assist in facility and infrastructure placement to avoid eiders. It also requires minimizing overhead lines and guywires. Transmission lines are required to be attached to VSMs or buried off-pad and marking devices are required for guywires. These requirements substantially reduce the collision risk by limiting hard to detect overhead transmission wires and making guywires more visible.

4.5.10-b.4 Conclusion

Under Alternative C, the types of disturbances related to vehicle, aircraft, pedestrian, and vessel traffic, routine maintenance activities, heavy equipment use, facility noise, and oil spill clean-up activities would be similar to those that would occur under the other alternatives. The potential for these disturbances to impact spectacled and Steller's eiders would be greater under Alternative C than the other alternatives, as the entire planning area would be available for leasing, and the overall level of development would be greater. The potential for habitat loss and alteration to affect eiders would also be greater under Alternative C, as compared to the other alternatives, as the amount of tundra habitat that would to be lost to gravel infrastructure could be greater, and there would be a greater potential for infrastructure to be located in areas of high eider use near Teshekpuk Lake. The potential for eider mortality resulting from collisions with vehicles and/or infrastructure and marine vessel traffic, or for an oil spill to impact threatened eiders, would be greater under Alternative C as compared to the other alternatives. In general, impacts to eiders from non-oil and gas activities, and from oil and gas activities, would likely be additive, except in those areas where the two types of activities overlapped. Impacts to eiders from exploration and development activities would also be additive, except where development activities occurred in areas previously disturbed during exploration. However, once exploration and development ceased in an area, eider populations and habitat could recover, reducing overall effects in the planning area. In areas where two or more activities occurred, overall impacts would reflect those impacts associated with the first activity and any new impacts associated with later activities. Because of the larger disturbance area, the potential for more oil and gas exploration and development activities, and increased barge traffic the potential for impacts to eiders under this alternative would be approximately 40% greater compared to Alternative A.

4.5.10-c Polar Bears

4.5.10-c.1 Activities Not Associated with Oil and Gas Exploration and Development

Subsistence hunting and disturbance of denning bears resulting from winter overland travel likely have the most effect on bears in planning area. There is no record of where bears are taken, so the how subsistence take impacts bears in or near the planning area is unknown, but on average 32 polar bears from the Southern Beaufort Sea stock are taken annually in Alaska (Angliss and Outlaw 2005). Winter overland travel not in support of oil and gas is likely relatively rare in the planning area and unlikely to result in significant disturbance effects. Research activities and close passes (<1 mile) may cause abandonment of a den if they occur early in the season but do not appear to have significant effects later in the season (Amstrup 1993).

4.5.10-c.2 Oil and Gas Exploration and Development Activities

Seismic

Under Alternative C, a small number of polar bears could be affected by seismic exploration occurring along the coast, although ROP C-1 would prohibit seismic activities within 1 mile of known or suspected polar bear dens or seal birthing lairs. The impact of seismic activities on polar bears utilizing the coast for denning, foraging, or resting could potentially be greater under Alternative C compared to the other alternatives.

Exploration

Under Alternative C, increased levels of exploratory drilling and development that could occur near the coast would increase the likelihood of displacing or attracting polar bears or causing den abandonment compared to Alternative A. Most polar bear dens near the planning area are off the coast, north of Teshekpuk Lake. The effects of exploration activities, including disturbance and potential spills, would depend on the scale and duration of the activity but could affect some polar bears.

Development and Production

Female polar bears denning within approximately one mile of construction activity could be disturbed by vehicle traffic and construction noise. If disturbance leads to premature abandonment of the den it could result in the potential death of cubs (Amstrup and Gardner 1994). The relatively greater amount of development anticipated under Alternative C increases the likelihood that activities associated with oil and gas could occur in the vicinity of denning polar bears, and that impacts to polar bears from oil and gas development and production would be greater than the other alternatives. However, the required set-backs under Lease Stipulation K-1 and K-4 from major rivers and the coastline respectively would reduce the likelihood of construction destroying potential den sites. Polar bears could be attracted to drill sites by food odors and curiosity, increasing the potential for negative human-bear interactions, and the possible death of bears in defense of human life and property. However, under current rules, policy, and practice there has not been a DLP taking reported in the Alaska oil fields (Schliebe et al. 2006).

As under other Alternatives, consultation between oil field developers and the USFWS would result in the use of nonlethal means of deterrence if necessary.

Contaminant Spill

Female polar bears select "bluffs" including river banks for denning habitat, thus they are more likely to be present in river drainages. Any spill that reached a river during late fall when polar bears are constructing dens, occurred in winter under ice, or in spring during broken ice periods could impact denning polar bears and their young if the spill was large enough to reach the den area in sufficient concentration. The potential for a spill is increased under Alternative C compared to other Alternatives due to the greater amount of oil expected to be produced.

Spring or summer spills that reached marine waters would have the greatest likelihood of impacting polar bears or their prey. Spills during broken ice or in the lead system would have the largest potential for an adverse impact on bears.

Polar bears are generally widely dispersed, thus any spill would be unlikely to affect more than one to three bears unless a very large spill occurred.

Effects of Abandonment and Rehabilitation

Effects would generally be the same as under construction and therefore would be expected to be greater under this Alternative compared to the others. Dismantling of equipment and modules and readying it for transport would most likely take place during summer. Transport of large or heavy material would be a winter activity and occur over ice roads. Any re-contouring or removal of gravel would primarily be done in the winter, although some summer activity may be necessary to finish. Any planting or monitoring would also be a summer activity. A combination of surface vehicles and aircraft would be required for transportation. The potential for large spills would be substantially reduced after shut-down. .

Commercial Gas Development

If natural gas development and production occur in the coastal areas used by polar bears, potential impacts would include those described above for oil development, such as attraction to waste from the facilities, though there would be no oil spill impacts. Denning female bears may be encountered during winter construction or maintenance activities. Aroused female bears may abandon the den, potentially leaving cubs. Additionally, increased energy expenditure could negatively impact the cub survival. Because more lands near the coast would be available for oil and gas development under this alternative than in Alternative A and because more development is likely to occur than under any of the alternatives, there is greater potential for impacts to polar bears under Alternative C than under any of the other alternatives.

4.5.10-c.3 Effectiveness of Stipulations and Required Operating Procedures

Alternative C would include the same performance based ROPs and Stipulations as Alternative B and D. ROP A-1 would minimize the potential for food waste to attract polar bears and the need for deterrence or take. The ROP is similar to current practice within the Prudhoe oil fields which has resulted in few deterrence actions and no DLP takings since implemented (Schliebe et al. 2006).

Required Operating Procedure C-1 would prohibit the cross-country use of heavy equipment and seismic activities within 1 mile of known or observed polar bear dens or seal birthing lairs. This ROP would also require operators to consult with the USFWS before initiating activities in coastal habitat between October 30 and April 15. Letters of Authorization reinforce the ROP and may result in area specific restriction that would further reduce the likelihood of adverse affect.

The K-1 Lease Stipulation would require 1-3 mile setbacks from the major rivers the planning area. This is expected to reduce the potential for disturbing denning bears in these areas. Pipelines could still cross these areas so the likelihood of a spill from a transport pipeline entering a river is possible, but spills from accidents on pads, parallel pipelines or at compressor stations would be very unlikely to reach the river banks.

Lease Stipulation K-6 would prohibit the placement of permanent facilities within ¾ mile of the coast, except where technological limitations, economics, logistics, or other factors necessitated a structure. Under these circumstances, the use of a previously occupied site (Camp Lonely, Husky/USGS drill sites, and DEW-Line sites) would be considered. The elimination of new permanent facilities within ¾ mile of the coast should be effective in reducing the potential for disturbance to polar bears and their prey and is expected to reduce the potential for disturbance (displacement or attraction) of polar bears along the coast.

4.5.10-c.4 Conclusion

Under Alternative C, ROPs and lease stipulations (as described under "Effectiveness of Stipulations and Required Operating Procedures") would prohibit the construction of permanent structures within ¾ of a mile of the coast, although exploration could occur in the area. The effects of exploration activities, including disturbance and spills, would be localized and would be unlikely to affect populations. Individual polar bears could be affected by exploration activities and seismic surveys in close proximity to polar bear dens and could cause abandonment of maternity dens by polar bears. Avoidance requirements are expected to result in only a small number of dens being affected.

Under Alternative C, impacts to polar bears and their habitat from oil and gas exploration and development will be greater compared to the other alternatives, as a greater area would be affected under Alternative C than under the other alternatives. The opening of the area north of Teshekpuk Lake would allow development in areas where polar bears are most likely to occur; however, coastal buffer and river buffer requirements should reduce the potential for adverse effects. The ROPs and Stipulations combined with the relative low density of denning bears near the planning area make it unlikely that Alternative C would have a significant effect on polar bear populations.

4.5.11 Cultural Resources

4.5.11.1 Activities Not Associated With Oil and Gas Exploration and Development

Under Alternative C, the types of effects of non-oil and gas activities on cultural resources would be the same as those discussed for Alternative A. Aircraft and watercraft traffic, scientific investigations (e.g., archaeological and paleontological surveys and excavations), summer camps, removal and remediation of hazardous and solid waste material, overland moves, and

recreation could affect cultural resources. Aircraft use would be unlikely to directly affect cultural resources, but could have minor indirect effects on cultural resources by making sites more accessible to recreationists and other users as could watercraft. The amount and types of recreational use occurring under Alternative C would not differ from that occurring under the other alternatives. However, the amount of scientific work occurring in the planning area could be greater under Alternative C than the other alternatives, as a larger area would be opened up to development. Other ground activities could also be more prevalent, relative to the other alternatives. Ground-disturbing activities, such as scientific camps and hazardous and solid waste material removal and remediation, would be monitored or surveyed for cultural resources before these activities occurred.

4.5.11.2 Oil and Gas Exploration and Development Activities

It is worth noting that cultural resources are not as ubiquitous in the planning area. Surface cultural resources which are structures of some type can usually be visually detected and avoided, even when covered by snow. Surface cultural resources that are not structures would not be easily detected, but given their characteristics would typically be sufficiently protected from impacts by snow cover and frozen vegetation. One exception would be human skeletal remains that lie on the ground surface. Because seismic data gathering activity would primarily occur during the winter using low-ground-pressure vehicles (ROP C-2), it is unlikely that this activity would affect undocumented subsurface cultural resources. Ice roads and pads used for exploratory drilling would have the location examined for the presence of cultural resources prior to the onset of exploration activities.

Effects of Disturbances

Under Alternative C, the amount of area impacted, and level of oil and gas exploration and development activities, would likely be greater than under any alternative because all lands in the planning area would be made available for leasing. However, because most surface-disturbing activities would occur during the winter months, the potential for impacts to buried cultural resources would remain relatively small. Surface cultural resources would not likely be affected because of their scattered occurrence, and because they would be protected by a variety of lease stipulations and ROPs governing oil and gas exploration activities.

Under Alternative C, the types of effects of possible disturbance would be the same as those occurring under Alternative A. Efforts to supply necessary materials for construction of gravel pads, airfields, and roads at this scale could increase the likelihood of damage to known or undocumented cultural resources in the planning area. The excavation of material (e.g., gravel) for the construction of the permanent facilities would be the primary source of potential effects to cultural resources. Pipelines would not have associated all-weather gravel roads or pads and would be constructed during the winter months from an ice road and pads. Therefore, the only effect on cultural resources resulting from aboveground pipeline construction would be associated with the placement of VSMs, and would depend on the depth at which the VSMs were set.

Effects of Abandonment and Rehabilitation

It is unlikely that cultural resources would be impacted by abandonment activities unless the facilities to be abandoned or removed during rehabilitation were themselves historic.

Effects of Spills

Under Alternative C, the effects of oil spills on cultural resources would be the same as those that would occur under Alternative A, though because there is an increased chance for more spills and more spilt oil, there would be a corresponding marginal increase in the potential impacts to cultural resources. In the exploration stage, most spills would occur on an ice pad or ice road and during winter conditions. In such a case, the spill or subsequent spill cleanup would probably not alter or destroy buried cultural resources, but could affect surface cultural resources by covering these resources with oil or other spill material. Warm oil, however, could melt through the snow and ice and impact cultural resources buried near the surface. A spill occurring during the summer would have a greater potential to affect surface and subsurface cultural resource sites than a spill occurring during the winter because the effects of both the spill and subsequent cleanup would be greater. Oil spills on cultural resource sites would cause damage proportional to the extent of contamination, and could require data recovery (excavation) as part of remediation and clean-up efforts. However, irreparable damage to some of the data could occur. Oil spills at cultural resource sites, either surface or buried, could make radiocarbon dating of that site problematic or impossible.

Commercial Gas Development

The types of impacts on cultural resources that natural gas development and production would cause would be the same as those caused by oil development described above, except that there would be no crude-oil spills, impact from creation of gravel pads would be increased for a 10- to 20-acre pad for a pipeline compressor station, and if a gas pipeline is buried—the likely method—there would be additional acreage disturbed with increased potential for disturbance or destruction of cultural resources. Impacts could be larger than for all other alternatives, because more buried gas pipelines are projected. It is anticipated that under Alternative C, burying the pipeline would result in digging up approximately 182 miles of four feet wide and five feet deep trench (approximately 90 acres, compared to 80 acres for the other alternatives) and potential surface disturbance of 240 acres (compared to 210 acres for the other alternatives) in areas adjacent to the trench from potential disturbance from machinery or placement of backfill. The risk to cultural resources would be reduced dramatically if gas pipelines are put on VSMs.

4.5.11.3 Effectiveness of Stipulations and Required Operating Procedures

Lease stipulations and ROPs identified for Alternative B would also apply to Alternative C and would effectively reduce the effects of oil exploration and development activities on cultural resources. Prior to any undertaking (i.e., ground-disturbing activities such as the construction of buried pipelines) on Federal lands, the NHPA would require that an archaeological resource survey be completed. If cultural resources were identified during such a survey, BLM guidelines and policy would require that all impacts to these resources be mitigated to the satisfaction of the land manager and the SHPO.

4.5.11.4 Conclusion

Under Alternative C, the overall potential effects on cultural resources from management activities other than oil and gas exploration and development would be as previously described. Overall, the probability of the occurrence of effects would be the largest among all the alternatives because by making all lands in the planning area available for leasing, Alternative C has the highest potential to affect the resources.

Approximately 2 to 3% of the planning area has been surveyed for cultural resources. The distribution of known cultural sites does not reflect locational preference of prehistoric and historic people, but rather indicates that only portions of the Planning Area (e.g., well sites, portions of the coast, the Colville River, the Ikpikpuk River, and the Teshekpuk Lake area) have been examined through some type of organized reconnaissance for the presence of cultural sites. The TLUI sites generally cluster in these same areas with greater density on the lower Ikpikpuk River and associated drainages (NSB 1978, 2003). The density of cultural resource sites in the area north of Teshekpuk Lake is also presumed to be high, thus there is an increased risk of inadvertent damage to these sites under Alternative C. Activities that occur near these areas may have a greater likelihood of impacting cultural resources. In the most general terms, where surveys and inventories have been conducted, cultural sites have usually been found. Since surveys are required before any ground-disturbing activity can take place, the potential for impacts to cultural resources from oil and gas exploration and development activities under Alternative C would be low.

In general, impacts to cultural resources from non-oil and gas activities, and from oil and gas activities, would likely be additive, except in those areas where the two types of activities overlapped. Impacts to resources from exploration and development activities would also be additive, except where development activities occurred in areas previously disturbed during exploration. In areas where two or more activities occurred, overall impacts would reflect those impacts associated with the first activity and any new impacts associated with later activities. Because of the larger disturbance area, and the potential for more oil and gas exploration and development activities, impacts to cultural resources under this alternative would be greater for oil and gas exploration and development activities, as compared to the other alternatives. Impacts could be greater, too, if oil and gas exploration and development activities occur in an area with a high concentration of cultural resources. These impacts, however, would be effectively mitigated by lease stipulations and ROPs that prohibit oil and gas exploration and development in areas with a high likelihood of having cultural resources, enforcement of lease stipulations and ROPs that prohibit collection of artifacts and require training of workers regarding avoidance of effects on cultural resources, and compliance with all Federal laws, including the NHPA, requiring for cultural resources in areas where ground-disturbing activities are proposed.

4.5.12 Subsistence

4.5.12.1 Activities Not Associated With Oil and Gas Exploration and Development

Alternative C makes 100% of the planning area's 4.6 million acres available for oil and gas leasing. It would utilize the same performance-based stipulations and ROPs developed for Alternative B to mitigate the impacts of energy development and other land uses on resources in the planning area. These protective measures would mitigate the impacts of energy development and other land uses, provide flexibility to BLM to adapt management decisions to uncertain or changing environmental conditions, and provide more consistent management by BLM across the entire northern portion of NPR-A. These restrictions are presented in Table 2-2 and pertain to the same activities and include the same seasonal and spatial restrictions as Alternative B. Under Alternative C, the effects of non-oil and gas activities would be similar to those that would occur under Alternatives A and B, but would be greater in extent, duration, and magnitude given that lease sales could occur in the entire planning area.

Effects of Disturbances

Aircraft Use. Under Alternative C, there would be greater use of aircraft than under the other alternatives, including air traffic necessary for sampling caribou and waterfowl in sensitive areas as part of wildlife monitoring. These activities could reduce subsistence harvests by diverting, deflecting, or disturbing subsistence species, such as migrating or insect-avoiding caribou, or seals, walrus, and whales. Given that a larger area would be open to leasing under Alternative C, these effects would occur over a larger area and for a longer duration than under the other alternatives. This could limit the availability of desirable subsistence use areas resulting in reduced subsistence harvest. It is possible that subsistence users would have to go farther to harvest subsistence foods, and would spend more time in pursuit of subsistence species, incur increased fuel cost, and face an increased risk of equipment failure and meat spoilage. Nuiqsut subsistence users have frequently stated during scoping meetings that aircraft traffic reduces harvest access and success, an issue that could affect Atqasuk and Barrow hunters if leasing were to open to the north and west of Teshekpuk Lake.

Watercraft Use. Under Alternative C, the effects of watercraft on subsistence harvest patterns would be the same as those discussed under the Alternative A.

Research Activities. The amount of scientific research and data collection activity would likely be greater under Alternative C than under the other alternatives. Under Alternative C, the types of effects from scientific research and data collection on subsistence species would be similar to those discussed under Alternative A. However, given that the extent, frequency, and duration of research and data collection activities would be greater under Alternative C, the temporary and localized diversion, deflection, or disturbance of subsistence species associated with research would also be greater. Therefore, there would be a greater likelihood that these activities would affect the success of subsistence harvests. Research activities would predominantly take place during the summer months. Aircraft-based biological surveys would have the greatest likelihood of affecting subsistence harvest patterns because they cover large areas, last a long time relative to other research activities, and are known to elicit responses from caribou and waterfowl. Archaeological, paleontological, and geological activities, involving personnel walking on the tundra, would have some short-term effects on subsistence species. Research and data collection activities could divert, deflect, or disturb subsistence species, which could affect subsistence harvest patterns by causing a temporary and local reduction in resource availability at traditional use areas.

Recreation. Similar to the other alternatives, recreational users would likely frequent waterways used by subsistence hunters during the summer months, potentially causing resource user conflicts. The effects of these conflicts on subsistence harvest patterns would likely be localized and of short duration. Since the amount of recreation that would occur would be more or less the same under all alternatives, effects to subsistence harvest patterns under Alternative C would be the same as those listed under Alternative A.

Solid and Hazardous Waste Removal and Remediation. As discussed under Alternative A, solid and hazardous waste removal and remediation activities would have localized effects that would last for the duration of the activity. Solid and hazardous waste removal and remediation, which would involve monitoring of existing clean-up sites and aging infrastructure (e.g., wellheads), would be ongoing, independent of the amount of land open to leasing. Therefore, the effects of these activities would be the same under all alternatives. Site cleanup and remediation activities could temporarily divert or disturb caribou, muskox, and grizzly and polar bears, but would have little effect on long-term subsistence harvest patterns. Evaluation

activities would have little effect on long-term harvest patterns. Over the long term, these activities could benefit subsistence species by reducing the potential for contamination of subsistence species with the cleanup of hazardous waste sites.

Overland Moves. Similar to Alternative A, overland moves would occur only by permit and would be subject to appropriate stipulations and ROPs. Stipulations and ROPs would mandate procedures to protect denned bears and minimize impacts to caribou. However, overland moves could temporarily deflect local subsistence species when they occur. Overall, the effects of overland moves on subsistence harvest patterns would likely be similar under all alternatives.

Conclusion

Under Alternative C, non-oil and gas activities could affect subsistence species, including caribou, waterfowl, muskox, moose, wolf, wolverine, and fox. These activities could divert or deflect subsistence species from normal harvest areas; reduce populations as a result of stress; cause a change in or loss of habitat and forage; or result in the contamination of, as well as the subsistence users' perception of contamination of, subsistence species. Under Alternative C, the effects of aircraft activity would be similar to those that would occur under Alternative A, except that the frequency, extent, and duration of aircraft use would be greater. A greater level of aircraft activity could result in a greater amount of temporary and localized diversion, deflection, or disturbance of subsistence animals, relative to Alternative A.

4.5.12.2 Oil and Gas Exploration and Development Activities

Allowing oil and gas activities to occur in areas that would not be available for leasing and year-round occupation under Alternatives A and B would increase the area potentially affected by these activities, increase the duration of those effects to approximately 40 years or longer, and spread those effects throughout the northern half of the Northeast NPR-A. This area was unavailable for leasing under the 1998 Northeast IAP/EIS ROD because it is a sensitive habitat that is important for calving caribou of the TLH and for molting, nesting, and fledgling waterfowl (USDOI BLM and MMS 1998). Under Alternative C, oil exploration would be ongoing and would involve seismic testing using low ground-pressure vehicle trains. A larger area would likely be exposed to drilling and temporary ice pads and roads than under both Alternatives A and B. Oil and gas activities would likely occur at a great magnitude and at more frequent intervals than under the other alternatives.

Effects of Disturbances

Aircraft Activity. Disturbance from aircraft activity related to oil development would potentially be greater under Alternative C compared to Alternative A. Twenty additional ice airstrips, and 2 additional gravel airstrips, are anticipated under Alternative C when compared to Alternative A. Activities related to aircraft use could disturb subsistence activities, which could in turn impact subsistence users. Some of these impacts include loss of money, loss of time, loss of subsistence food, increase cost in fuel, increased degradation on equipment, increase stress and anxiety and increase risk of loss of life or serious injury. These impacts could lead to a greater need for emergency search and rescue responsibilities by local governments.

Seismic Survey Activity. Under all alternatives, it is anticipated that five additional seismic surveys, three 2-D and two 3-D, would be conducted within the planning area in order to cover

all gaps where seismic has not yet occurred. The three 2-D surveys are projected to potentially impact a total of 8,126 acres, which is the combined total of acres impacted by the survey and acres impacted by the camp train overland move. The two 3-D surveys are estimated to potentially impact a total of 99,870 acres, combined. It is also assumed that the surveys would occur in those areas currently not covered by 3-D surveys, which include the foothills area and the area north and east of Teshekpuk Lake (see Figure 4.6). The effects of seismic exploration would be the same as those described under Alternative A (see **section 4.3.12.2**).

Exploratory Drilling. Under Alternative C, it is estimated that 120 exploratory wells will be drilled in the planning area, with an additional 90 delineation wells drilled in subsequent years near wells that showed potential as oil producers. Wells that do not indicate the presence of hydrocarbons in developable quantities will be plugged and abandoned. Wells that show potential may be "suspended," and capped with what is known as a "Christmas tree" at the surface. It is anticipated that, at most, 8 drill rigs will be operating in the planning area in any given winter season, an increase (relative to Alternative A) of 3 rigs under this alternative.

Impacts as a result of exploratory drilling under Alternative C will be identical to those described under Alternative A; however, given the increase in proposed activity, the effects on subsistence use would be greater in magnitude, extent, and duration. In addition, opening the entire planning area to exploratory drilling increases the likelihood of subsistence user-conflicts with oil and gas activities. And, as discussed under Alternative B, the more anticipated activity, the greater the increase in conducting necessary studies prior to the winter drilling season (see **section 4.4.12.2**). Overall, Alternative C results in the greatest potential impact to subsistence use as a result of exploratory drilling.

Development and Permanent Facilities. Under Alternative C, it is estimated that there will be a need for seven central processing facilities (90 acres each) in the planning area. In conjunction with these facilities there are other support structures, such as gravel production pads, gravel runways in-field gravel roads, several types of pipelines, and other associated structures, that will also cause surface disturbances. It is estimated that under Alternative A, there will be: 32 gravel production pads (10 acres each); 7 gravel runways (11 acres each); 320 miles of in-field gravel roads (7.75 acres/mile); 320 miles of three-phase produced fluids (oil, gas, water) gathering lines; 182 miles of sales oil pipelines; 7 pump stations (20 acres each);4 staging bases (50 acres each); and 16 gravel pits (50 acres each). It is estimated that during the construction phase of these facilities that the total disturbance would be 6,170 acres. Construction of the permanent facilities will primarily take place during the winter, using ice roads and pads in the area of development to move and stage machinery, supplies, personnel and housing. It is estimated that construction for a typical development would take a minimum of 3-6 years. During this construction phase, it is estimated that there would be an average of approximately 115-160 one-way aircraft flights per month during the winter, and 70-90 one-way operational flights per month during the summer. Construction activities could result in an economic boon to local communities, and could directly affect harvesters if they were hired by the companies. This increase in income could offset the increased cost of fuel needed to harvest displaced resources, but might also lead to a corresponding decrease in the amount of time a harvester could be out on the land depending on the work schedule (see **sections 4.4.13.2 and 4.4.18.2** for further discussion on economic impacts).

As compared to the other alternatives, the extent, severity, and duration of effects would likely be greater under Alternative C, given that a larger area would be open for year-round occupation and development, which would include ecologically sensitive areas that would not be open under the other alternatives. The amount of habitat loss and degradation would be greater

under Alternative C than under the other alternatives. It is possible that there would be some change in caribou and waterfowl populations and distribution because of oil and gas activity in this area, despite the protections granted by the lease stipulations and ROPs. Post-parturient caribou and calves could be deflected or diverted from preferred habitats in the vicinity of Teshekpuk Lake if development were to occur in that area (Murphy and Lawhead 2000). Migrating caribou could be delayed or deflected by vehicle and aircraft traffic, as well as other human activity, during development and construction; however, caribou would likely habituate to the new infrastructure and activity (except human presence) over time (Murphy and Lawhead 2000; USDOI BLM 2003).

Waterfowl could be temporarily displaced from nesting areas, but would adapt quickly to most new activities during development and construction (Johnson 2000a, b; Ritchie and King 2000; Sedinger and Stickney 2000). Fox populations tend to increase in response to development, as gravel pads, food waste, and other human activity provide favorable habitat and energy inputs for these species (Burgess 2000). These predatory scavengers in turn cache waterfowl eggs and feed on fledgling and molting birds, thus reducing their breeding success and in some cases depleting local populations (Burgess 2000; Sedinger and Stickney 2000).

Fish habitat should be protected adequately by lease stipulations and ROPs; however, development in freshwater lakes could cause changes in turbidity, salinity and dissolved oxygen levels, possibly reducing fish populations in those lakes. Given the larger area available for leasing, the effects of disturbance from oil and gas activities on subsistence species would be greater under Alternative C than under the other alternatives.

The areas that would be newly available for leasing under Alternative C is an important caribou harvest area for Barrow. In addition, the communities of Barrow and Atqasuk fish in the vicinity of Teshekpuk Lake and along the Beaufort Sea coast between Atigaru Point and Smith Bay. As noted in Alternative A, Nuiqsut residents are already excluded from utilizing traditional use areas east of the Colville River and delta, and planned development could inhibit subsistence use of the northeast corner of the planning area. Oil and gas development further to the west and south could negate Nuiqsut's strategy of using snowmachines and outboards to travel to more distant subsistence harvest locations and return in time to fulfill obligations in town. Alternative C would have a greater effect on subsistence harvest patterns than the other alternatives because of the increased area of potential activity, the longer duration of oil and gas activity in the area, and the greater extent of possible development.

Conclusion

Because Alternative C makes the entire planning area available for oil and gas leasing, the increased oil and gas activity that could occur over a wider area could inhibit subsistence users from harvesting in their traditional use areas to a greater degree than under all other alternatives. Hunters from Barrow and Atqasuk would be directly affected by development north and west of Teshekpuk Lake, where numerous subsistence camps, cabins, and ice cellars are located. Until caribou became habituated to activity and infrastructure in the area, there could be reductions in subsistence harvest success or increased effort, time, risk, and expense involved in order to harvest adequate amounts of subsistence resources. Nuiqsut subsistence users would be affected by increased activity in the northeast portion of the planning area, and activity farther west could deflect migrating caribou away from other traditional harvest locations, reducing harvest access and success. If oil and gas activities were to divert or deflect the normal migration routes for the TLH caribou, Anaktuvuk Pass subsistence users could suffer a shortage of caribou, requiring greater expenditures and risk. In the past, when the

herd has failed to pass near the community, hunters had to fly to more remote locations in search of subsistence food, increasing community stress and the time necessary for harvest success, as well as reducing the connection with traditional areas (SRBA 2003b).

Under Alternative C, disturbances associated with oil and gas activities would be similar to those discussed under the Alternative A; however, the effects on subsistence resources would be greater in geographic extent and duration, as a greater amount of potentially sensitive habitats would be open to leasing. In addition, areas that would be off limits to development under Alternatives A and B would be open to leasing and could be affected by oil and gas development. As noted in Alternative A, oil and gas development could inhibit subsistence harvesters' use of the traditional harvest areas, which could reduce harvest success and increase associated costs, efforts, and risks. Of the alternatives discussed in this document, Alternative C has the greatest potential to impact subsistence use.

Effects of Abandonment and Rehabilitation

During oil facility abandonment and rehabilitation activities, which include the removal of all equipment and facilities, and the plugging of all wells, subsistence resources and activities would be subject to impacts similar to those caused by construction as described under Alternative A (see **section 4.3.12.2**). Following the abandonment and rehabilitation, subsistence resources would be subject to fewer impacts. If the gravel roads and pads were left in place and remained serviceable, they could be used by residents to provide access to subsistence resources, possibly reducing hunting effort and time.

Effects of Spills

Under Alternative C, it is assumed that 3.038 large spills (e.g., greater than or equal to 500 barrels of oil, but less than 120,000 barrels) consisting of an estimated 14,582 barrels of oil, could occur in the planning area. These spills would consist of unrefined crude oil from a pipeline, or possibly as much as 900 barrels of crude or diesel oil from a gravel pad facility. Small spills (e.g., less than 500 barrels) are currently the most frequently-occurring spill type on the North Slope, and primarily consist of the release of less than a barrel of aviation fuel, diesel fuel, engine lube oil, fuels oil, gasoline, grease, hydraulic oil, transformer oil and transmission oil. Under Alternative C it is estimated that a total of 721 small crude oil spills and 1,782 refined oil spills could occur in the planning area. A very-large spill, defined as a spill greater than or equal to 120,000 barrels of oil, is considered extremely unlikely to occur within the lifetime of this plan.

The risk of oil spills under Alternative C would be similar to that under Alternative A; however, a greater area of important caribou, waterfowl, and fish habitat would be subject to potential contamination by oil spills. The area surrounding Teshekpuk Lake and north to the Beaufort Sea, largely unavailable for leasing and/or year-round occupation under Alternative A and partially unavailable under Alternative B, would be open for year-round development and operation under Alternative C. Subsistence users have stated that they prefer not to hunt in industrial areas, and the communities of Barrow, Atqasuk, and Nuiqsut have harvested resources in the area to be opened under Alternative C. The communities of Barrow, Atqasuk, and Nuiqsut rely greatly on the TLH caribou for subsistence, and Wainwright and Anaktuvuk Pass utilize the herd to a lesser extent. Large oil spills could affect subsistence patterns by reducing populations of subsistence species, contaminating subsistence species or their habitats, resulting in the resource being unfit to eat or polluted. These effects could reduce the amount of subsistence foods harvested, cause changes in traditional diets, increase risks and wear and

tear on equipment if users were required to travel farther to find more suitable resources, and cause social stress due to the reduction or loss of preferred foods harvested in the traditional fashion. Effects on subsistence harvest patterns would be greater under Alternative C than under the other alternatives because oil and gas activity would likely occur over a larger and more ecologically sensitive area, and the likelihood of an oil spill occurring would be greater.

Commercial Gas Development

Effects on subsistence resources and harvest patterns from natural gas development and production under Alternative C would occur in much the same way as effects would occur under that alternative from oil development and production, though there would be no crude oil spills from gas production. Because Alternative C makes more important subsistence resource habitat and subsistence use areas available for leasing and development than the other alternatives, it would likely result in the greatest amount of impacts to subsistence. Winter burial of the pipeline would potentially disrupt caribou and subsistence hunters, though once buried, a gas pipeline should not have additional impacts on subsistence. If a natural gas well blowout occurred, the subsistence harvest of any species in the vicinity could be affected and, if an explosion and fire occurred, subsistence resources in the immediate vicinity could be killed. Natural gas and condensates that did not burn in the blowout would be hazardous to any organism exposed in high concentrations. However, natural gas vapors and condensates would be dispersed very rapidly from the blowout site (1 km downwind for about 1 day) and would affect only those species in the immediate vicinity of the accident. While such an effect would be relatively short term and localized and likely would not measurably affect the regional population of any species, it could cause disruption to subsistence harvests in the area of the blowout. In addition, subsistence hunters, who already tend to avoid oil field infrastructure, may be even more likely to avoid gas fields for fear of a well blowout.

4.5.12.3 Effectiveness of Stipulations and Required Operating Procedures

The performance-based lease stipulations and ROPs developed for Alternative B would also apply to Alternative C (see **section 4.4.12.3** for an assessment of the effectiveness of the ROPs and lease stipulations). Under Alternative C, no areas would be withdrawn from year-round occupation except the buffer zones around deepwater lakes, with the same exception clauses as the other alternatives. Under this alternative, oil exploration and development could occur over a wider area, in more sensitive areas and habitats, and in lakes; however, ROPs and lease stipulations would be included (e.g., ROPs H-1 and H-2) to effectively reduce conflicts between subsistence uses and oil and gas activities. As stated during scoping, subsistence users stated that the proposed revision to the 1998 Northeast IAP/EIS is a breach of faith and that opening up more areas in the planning area would have negative effects on subsistence users from Barrow and Nuiqsut (Ahmaogak 2003).

Local municipal government and tribal governments generally have few paid staff and limited funding. Local government official and tribal leaders feel they are overtaxed when asked to provide meaningful input to BLM on permitted activities. Many residents have stated during scoping that the change from the prescriptive lease stipulations in the 1998 Northeast IAP/EIS ROD to performance-based ROPs and lease stipulations places them in the position of having to defend subsistence interests because compliance is now defined in terms of meeting a management objective rather than meeting an absolute prescriptive standard. To effectively respond, they would have to further stretch their existing capabilities to review and comment on industry proposals and their impact on subsistence.

BLM holds that performance-based lease stipulations and ROPs would provide equivalent protection, while gaining flexibility for adaptive management. The flexibility of the new approach places greater reliance on close, on-going monitoring to insure that these procedures do in fact achieve equivalent protections. BLM is committed to directing the necessary resources to this on-going monitoring requirement, including support for the continuing work of the Subsistence Advisory Panel to provide oversight, exchange information, and develop solutions for any emerging issues.

4.5.12.4 Conclusion

Most impacts associated with oil and gas activities under Alternative C would be localized and would not substantially affect subsistence species, as long as the activities occurred outside of key habitat areas or migratory zones when animals were present. Permanent facilities associated with development, if located in key migration corridors or other areas essential to the viability of the population, could result in reduced harvests, and a reliance on other sources of food. The ROPs and lease stipulations discussed above would be effective in protecting subsistence species and helping to resolve conflicts between the oil and gas industry and local residents. Even in the best case scenario of species protection, however, subsistence users would still be constrained by the presence of oil and gas facilities from harvesting subsistence resources, would question the health of those resources, and would tend to harvest resources at least 5 miles from areas of development, increasing the distance hunters must travel, and reducing the total harvest area available, with each new wave of development. As expressed in public scoping testimony, local residents are fearful for the future of subsistence hunting on the North Slope, their ability to carry on with traditional customs and ways, and their ability to be able to pass along these traditions to their children. Of the alternatives discussed in this document, Alternative C has the greatest potential to impact subsistence use.

4.5.13 Sociocultural Systems

4.5.13.1 Activities Not Associated With Oil and Gas Exploration and Development

Under Alternative C, the effects of non-oil and gas activities (e.g., aircraft and watercraft use, scientific research and data collection, recreation, overland moves, and solid and hazardous waste removal and remediation) on sociocultural systems would be greater than those expected to occur under the other alternatives. There would be a greater amount of scientific research and data collection and associated aircraft use undertaken prior to lease sales and as part of Federal land management responsibilities under Alternative C, as additional lands were opened to leasing, which could cause temporary and localized diversion or deflection of subsistence species. It is not expected that the amount of recreation and solid and hazardous waste removal and remediation would be greater under Alternative C, as compared to the other alternatives, but more overland moves could be required to support scientific and other activities in the additional areas available for leasing. Several families with members in Atqasuk, Barrow, and Nuiqsut use cabins, camps, caches, and other sites along the coast and inland to Teshekpuk Lake for subsistence activities. The use of these localities helps maintain family connections and a feeling of relatedness and stability, which could be reduced by increased activity in the areas formerly unavailable for leasing. In general, effects from non-oil and gas activities under Alternative C would be temporary and localized, and would be unlikely to affect overall sociocultural patterns.

4.5.13.2 Oil and Gas Exploration and Development Activities

Oil and gas exploration, development, and production in the areas formerly unavailable for leasing north of Teshekpuk Lake, outside the setbacks established in the lease stipulations and ROPs, would require, a seasonal network of ice roads, permanent gravel roads, pads, and runways, and a year-round corridor for pipelines and powerlines to each pad and production facility.

Effects of Disturbances

The effects on sociocultural patterns from disturbances caused by oil and gas activities under Alternative C would be the same as under Alternative A, but would be greater in intensity, as compared to the other alternatives (refer to Alternative A, **section 4.3.13**, for further discussion of effects). Increases in the amount of area available for leasing and exploration would have a corresponding increase in the effects to subsistence harvests as compared to those for Alternative A.

The development proposed for the planning area would require staging and overland travel during the winter and in summer would require several aircraft for supplies, equipment, and crew changes. In all seasons, noise, lights, personnel, and traffic near oil and gas infrastructure could deflect or divert caribou in areas where activities were occurring; however, gravel pads could attract caribou during some seasons as insect-relief habitat. These effects could change the distribution, timing, and location of the caribou harvest, which could then require increased effort and expenditure on the part of subsistence hunters, resulting in increased stress and a decreased sense of well-being. Oil and gas development could divert subsistence users at distances from 5 to more than 25 miles from facilities. Given the high gasoline costs on the North Slope, this would add additional cost to subsistence harvests. Increased fuel costs and wear and tear on equipment would increase the need for wage labor to support subsistence pursuits and reduce the time available to pursue subsistence activities, which would result in sociocultural consequences, such as increased stress and a decreased sense of well being. These problems are discussed in more detail in **section 4.5.19**. Increases in the speed, range, and reliability of outboards and snowmobiles have facilitated the mixed subsistence and wage economy, but are unable to compensate for impacts to subsistence activities from continued development and production activities in important subsistence harvest areas.

As discussed under Alternative A, long-term change to sociocultural patterns would result from a weakening of traditional stabilizing institutions through prolonged stress and disruptive effects that could be exacerbated by activities occurring under this amendment. These changes are already occurring to some degree on the North Slope because of onshore oil and gas development, more dependence on a wage economy, higher levels of education, improved technology, improved housing and community facilities, improved infrastructures, increased presence of non-Natives, increased travel outside of the North Slope, and increasing presence of television and the Internet. Data from other circumpolar Inuit populations suggest that continued modernization is associated with a trend toward displacement of sociocultural systems, including: a trend toward less time being spent conducting subsistence harvest activities; less subsistence consumption among younger generations; a greater focus on a cash-based economy, as opposed to the egalitarian sharing network; an increased importance on the nuclear family, as opposed to the more-traditional extended family structure (Curtis et al. 2005; Nobmann et al. 2005; Condon et al. 1995). North Slope Borough institutions, such as the school district that promotes the teaching of Iñupiat language and culture, the Arctic Eskimo Whaling Commission that negotiates with industry to protect Iñupiat subsistence whaling interests, the

NSB Department of Wildlife Management, and other regional and village Native corporations and organizations, have been working vigorously and quite successfully at preventing the weakening of traditional Iñupiat cultural institutions and practices. Increased social interactions between oil-industry workers and Nuiqsut residents could be long term, but there is not expected to be a tendency toward displacement of Iñupiat social institutions. However, population changes in ethnicity, such as the influx of a large non-native population, could disrupt or displace existing sociocultural systems and cultural institutions. Small-scale changes in population and employment are unlikely to disrupt sociocultural systems or displace existing institutions (USDOI BLM and MMS 1998, 2003).

Effects of Abandonment and Rehabilitation

Abandonment and rehabilitation activities would likely generate jobs for local residents for several years above the level that would exist during operations. However, after the production pads were shut down and closure activities were completed, jobs associated with them would cease. If local residents were to become substantially integrated into satellite operations and the community was to become substantially dependent on revenues associated with their operation, and if other oil fields were not active in the area to provide jobs and contribute economically to the local economy and government revenues, the community would face a time of significant economic depression; other potential avenues for maintaining income at the standards established in the oil development era have not been identified. Subsistence resources would be subject to fewer impacts, potentially improving subsistence opportunities.

Effects of Oil Spills

The effects of oil spills would be the same as discussed in Alternative A; however, under Alternative C there would be a greater likelihood that widespread damage would occur in sensitive habitats, as sensitive habitats that would be closed to leasing under Alternatives A and B would be open to oil and gas activity under Alternative C. Dispersion and contamination of important subsistence resources in these highly sensitive habitats could occur in the unlikely event of a large or very large spill. Effects would vary in severity depending upon the timing and location (i.e., terrestrial, riverine, lacustrine, or marine) of the spill event, but fish, waterfowl, and marine and terrestrial mammals could all be affected. Such a spill could result in contamination of subsistence resources and threaten the health and lifeways of the affected communities. If a large oil spill occurred in a traditional use area, then subsistence users would have to travel further to harvest uncontaminated resources, which would result in high effects to sociocultural patterns as long as the residents believed that the subsistence resources were contaminated.

Commercial Gas Development

Effects on sociocultural systems under Alternative C and all other alternatives would be due to effects on subsistence harvest patterns, changes in employment and population, and effects on public health. In the event of natural gas development and production in the planning area, there could be an increase in employment and population in some North Slope communities, subsistence use patterns and public health may be affected as described in **4.5.12 and 4.5.19**, respectively. The amount of employment and population change would probably differ among the alternatives in rough proportion to the amount of oil production and infrastructure development that would occur under each alternative; therefore, it is likely that the greatest amount of employment and population impacts would occur under Alternative C.

4.5.13.3 Effectiveness of Stipulations and Required Operating Procedures

The performance-based lease stipulations and ROPs proposed under Alternative C are the same as those proposed under Alternative B. As these mitigation measures have been in effect for only a short time in the Northwest NPR-A, their effectiveness cannot yet be empirically evaluated. The proposed performance-based lease stipulations and ROPs would provide equivalent or greater setbacks from rivers and lakes than under Alternative A. Other protections would be similar to those developed for Alternative A.

BLM proposes the new approach to mitigation measures in order to achieve equivalent protection as would occur under Alternative A, while providing greater flexibility. The prescriptive approach adopted in 1998 gained legitimacy and credibility through the extended consultation leading to the final decision, while the new approach proposed for Alternatives, B, C and D is not well known or understood, and some local residents doubt that the new approach would provide equivalent protection. The flexibility of the new approach places greater reliance on on-going monitoring to insure that modified procedures do in fact achieve equivalent protections.

4.5.13.4 Conclusion

New lease sales in the areas north of Teshekpuk Lake, which would be unavailable for leasing under Alternative A, and to a lesser extent under Alternative B, could cause societal stress in Barrow, Nuiqsut, and Atqasuk. Construction and operation of oil facilities could discourage families from using and maintaining traditional camps, cabins, and caches in the affected areas, which could affect social organization and cultural values in these communities. Development in these areas could increase North Slope residents' concerns about encroachment; potential risks to subsistence resources in terms of access and availability; and contamination of caribou, fish, and waterfowl. Visits to traditional camps and cabins are a vehicle for transmitting traditional and family history and knowledge to younger generations, and the discontinuation of such visits would decrease social cohesion in these communities. In addition, as harvests decreased, resources would no longer be available in amounts suitable for sharing, resulting in changes in social organization and cultural values.

4.5.14 Environmental Justice

4.5.14.1 Activities Not Associated With Oil and Gas Exploration and Development

The non-oil and gas activities likely to occur in the planning area would primarily be transitory in nature, of short duration, and highly localized. They could temporarily divert, deflect, or disturb subsistence species from their normal patterns. Non-oil and gas activities could alter the availability of subsistence species in traditional harvest areas, which could in turn affect harvest patterns by requiring hunters to travel further in pursuit of resources. Increased travel distances would result in greater expenditures for fuel and equipment, and increased wear and tear on snowmobiles, outboards, and four-wheel vehicles, and could result in a higher risk of accidents. Consequently, there could be an effect on the subsistence hunting activities of the local minority population as a result of non-oil and gas activities. Under Alternative C, these effects could be greater than under the other alternatives, but would still be minor, temporary, short term, and generally highly localized. As outlined in **section 4.5.19**, this could result in isolated problems of social pathology.

4.5.14.2 Oil and Gas Exploration and Development Activities

Effects of Disturbance

Under Alternative C, allowing oil and gas activities in areas formerly unavailable for leasing and year-round occupation could increase the amount of area affected by these activities, increase the duration of those effects, and spread the effects throughout the northern half of the planning area. Disturbances caused by Alternative C would be the same as those discussed under the other alternatives, but effects on subsistence caused by oil and gas development would be greater in magnitude, extent, and duration. For species unable to habituate to disturbances associated with oil and gas development, effects could potentially last for more than 40 years. Public health effects relating to sociocultural and dietary change, as well as exposure to contaminants, could persist for considerably longer.

Alternative C could have long-term effects on several terrestrial mammal species. In particular, effects on caribou herds would likely be greater than under the other alternatives. It is expected that effects on waterfowl harvested for subsistence would be more frequent and more widespread than under the other alternatives, given the greater area available for petroleum leasing. Little or no effect on marine mammals would be expected from onshore activities under Alternative C, but noise and disturbance associated with offshore barge and vessel traffic could impact bowhead whale migration patterns. There are concerns that, depending on the particular activity and, especially, the location of the activity, actions occurring under Alternative C, as under the other alternatives, could cause local effects on fish. It is believed that disruptions from Alternative C would affect caribou, waterfowl, and fish. All of these effects would be experienced primarily by the subsistence dependent minority Iñupiat population.

Under Alternative C, the possibility of public health impacts would be greater than under the other alternatives. These impacts would occur primarily through restriction in subsistence; influx of large numbers of outside workers; new access routes to the community; sociocultural and economic change; altered employment; and contaminants. Diabetes, hypertension, and related metabolic disorders would be expected to increase as subsistence is curtailed or as sociocultural changes lead to alterations in dietary patterns. Given that Alternative C involves the potential of development throughout the entire region, the risk of dietary change leading to metabolic disorders and of food insecurity are both substantially higher. The risk of contaminant-based health problems would also be highest under Alternative C, owing to the increased total emissions projected, as well as the distribution of emissions sources throughout the subsistence range. Social pathology could result from the economic changes anticipated; from increasing access to drugs and alcohol; and from stress and maladaptive coping given the impacts to wider regions of important traditional use areas. While measures such as Stipulation I-1, which mandates a cultural orientation program, it would not be expected to entirely offset the large-scale socio-economic impacts discussed in the sociocultural and public health sections.

Effects of Abandonment and Rehabilitation

Activities associated with dismantling and removing of production pads and facilities could disproportionately impact Nuiqsut residents through disturbance, displacement, and mortality of subsistence resources, through subsistence users' avoidance of areas undergoing dismantlement and removal, and through potential impacts to water and air quality, and noise. Once abandonment and rehabilitation were completed, Nuiqsut residents would be

disproportionately impacted by the reduction in local and Native corporation revenues and by fewer local jobs and business opportunities. Since economic depression is associated with increased social pathology, this could result in increases in domestic violence, injury, drug and alcohol problems, and suicide. Local residents could benefit from a reduction in impacts on subsistence resources, compared to during construction and operation.

Effects of Oil Spills

As discussed elsewhere, the magnitude of effects of a crude oil spill on subsistence resources would depend on the context of the spill, the volume and area covered by spilled product, and the amount of time the product was loose before clean-up efforts commenced. Tundra oil spills could affect small numbers of terrestrial mammals and waterfowl unable to avoid the spill area, but would be unlikely to have population level effects. Oil spills (any size) directly into a water body, particularly in difficult to contain conditions such as breakup or broken ice, could spread widely and have long-term, population level effects on fish and waterfowl. In the nearshore environment, a large to very large spill, particularly during broken ice or storm conditions, could affect marine mammals including seals, and beluga and bowhead whales. Oil spills can also be associated with toxicological health effects in human populations, as outlined in **section 4.5.19**. Furthermore, if a large spill resulted in a substantial decrease in consumption of subsistence foods, food insecurity and hunger as well as diabetes and related metabolic disorders could increase.

As compared to the other alternatives, a greater area would be at risk for oil spill damage under Alternative C. The area surrounding Teshekpuk Lake and north to the Beaufort Sea, largely unavailable for lease and/or year-round occupation under Alternative A, would be open for year-round development and operation under Alternative C. Subsistence users have stated that they prefer not to hunt in industrial areas, and the communities of Barrow, Atqasuk, and Nuiqsut have harvested resources in the area to be opened under Alternative C.

The Iñupiat people consider contamination from oil spills in nearshore waters to be a catastrophic possibility that would threaten their very existence, primarily because of the potential effects of spills on bowhead whales, which are a very important part of their culture in addition to being a favored food source (Brower 1976, Itta 2001). A major oil spill would result in effects that would impact Iñupiat subsistence users more than any other human group.

Commercial Gas Development

Environmental Justice impacts of gas development for Alternative C would be largely attributable to impacts to subsistence, sociocultural changes, and public health impacts and are described, respectively, in **sections 4.5.12, 4.5.13, and 4.5.19**. While impacts from an oil spill would not be a factor, it is possible that well blowouts or the fear of blowouts would increase subsistence users' avoidance of infrastructure. The proportional impacts among the alternatives would mirror that attributed to oil development, and therefore the largest impacts would likely result under Alternative C.

4.5.14.3 Effectiveness of Stipulations and Required Operating Procedures

Alternative C would utilize performance-based ROPs and lease stipulations patterned after those developed for Alternative B. The lease stipulations and ROPs would be effective in reducing conflicts between subsistence uses and oil and gas activities.

4.5.13.4 Conclusion

Several lease sales have already taken place in the planning area, and development in the northeastern portion of the planning area is underway (USDOI BLM 2003a), albeit not on BLM lands. Exploration programs, consisting of seismic testing and drilling using ice pads, are ongoing. Residents of Barrow, Nuiqsut, and Atqasuk have noted some effects from these activities on subsistence (SRBA 2003a, b). One effect included the redistribution of caribou, wolves, and wolverines in response to seismic activity and cat trains operating in the NPR-A (SRBA 2003a, b). These effects would continue under Alternative C, and would be somewhat greater than under the other alternatives. Most effects of disturbance would be greater in duration, extent, and magnitude. Effects from oil spills would depend greatly on the size, location, and season of the spill. Small spills on gravel pads would have little or no environmental justice effects. A major spill into a watercourse could have long-term, serious effects on Iñupiat subsistence activities. While any major spill would have serious consequences, the worst, from an environmental justice standpoint would be one that occurred in a key harvest area or near a community, particularly Nuiqsut or areas used by Barrow residents in the northwest portion of the planning area.

The activities likely under Alternative C could also have substantial health effects, as outlined above and discussed in detail in **section 4.5.19**. Because the population within and near the planning area is primarily comprised of Iñupiat, any health effects that occur would disproportionately affect this minority population.

4.5.15 Coastal Zone Management (Alternative C)

4.5.15.1 Activities Not Associated With Oil and Gas Exploration and Development

As non-oil and gas activities are normal occurrences under existing BLM management practices, they would in most cases, be of limited duration and magnitude, and effects on neighboring uses primarily subsistence resources and harvest patterns of nearby communities would be limited to the immediate area of the activity. Activities would be consistent with ACMP standards.

Under Alternative C, the effects of non-oil and gas activities on coastal resources would likely be slightly greater in duration, aerial extent, and, perhaps magnitude than those that would occur under the other alternatives. Under Alternative C, aircraft and watercraft traffic could increase during the summer to support the increased scientific and other activity necessary prior to expanding lease areas. This additional traffic could result in increased effects on subsistence species and increased irritation of Native communities.

There would be more scientific research and data collection under Alternative C compared with the other alternatives, pursuant to greater exploration and development activities. As a result, effects on subsistence activities would be greater.

It is expected that the planning area would support similar amounts of recreation under Alternative C, compared to the other alternatives.

Solid and hazardous waste removal and remediation activities, such as monitoring of existing clean-up sites and aging infrastructure (e.g., wellheads), would be ongoing, independent of

additional lease availability. The effects of solid and hazardous waste removal and remediation under Alternative C would likely have the same effects as the other alternatives.

Compared to the other alternatives, there could be a greater number of overland moves under Alternative C in order to stage research camps and activities. Overland moves would be permitted, subject to the lease stipulations and ROPs, similar to the prior alternatives.

4.5.15.2 Oil and Gas Exploration and Development Activities

Alternative C would involve ground-impacting management actions similar to those addressed for the other alternatives, but on a larger scale. As described in section **4.3.15, *Coastal Zone Management*** of this document, Section 307(c)(3)(B) of the CZMA requires applicants to certify that each of their activities that affects any land use or water use in the coastal zone complies with, and would be implemented consistent with, the state's coastal program. In the following discussion, ACMP standards for uses and activities are used to evaluate activities and effects that would occur under Alternative C. Policies of the NSB CMP are assessed in conjunction with the most closely associated statewide standard.

This analysis is not a consistency determination pursuant to the CZMA of 1972, as amended, nor should it be used as a local planning document.

Effects of Exploration and Development Related to the Alaska Coastal Management Program

Coastal Development (11 AAC 112.200)

Water dependency is a prime criterion for development along the shoreline. The intent of this policy is to ensure that onshore developments and activities that could be placed inland would not displace activities that depend on shoreline locations, which include marine shores, lakeshores, and river waterfronts. Under Alternative C, the entire Beaufort Sea coast within the planning area would be open to leasing. Lease Stipulation K-6 would be highly effective in discouraging permanent oil and gas facilities within ¾ mile of the coast and other lease stipulations would address sensitive issues areas along parts of the coast and near deep water lakes and major creeks and rivers.

Natural Hazard Areas (11 AAC 112.210)

This statewide standard permits coastal districts and state agencies to identify and designate areas in which natural hazards are known to exist that may present a threat to life or property. Development in these areas would be prohibited until siting, design, and construction measures for minimizing property damage and protecting against the loss of life were provided.

Flooding, earthquakes, active faults, tsunamis, landslides, volcanoes, storm surges, ice formations, snow avalanches, erosion, and beach processes in the planning area should be considered. Onshore development would be sited in areas of permafrost. Development in these areas would be required to maintain the natural permafrost insulation quality of existing soils and vegetation (NSB CMP 2.4.6[c] and NSBMC 19.70.050.L.3). Actions that occur under Alternative C would be required to comply with this standard.

Coastal Access (11 AAC 112.220)

Districts and state agencies shall ensure that projects maintain and, where appropriate, increase public access to, from, and along coastal water. It is expected that Alternative C would be consistent with this standard, although, as under Alternative D and Alternative B, the larger leasing area along the Beaufort coast could result in some conflicts with access opportunities, as compared to Alternative A.

Energy Facilities (11 AAC 112.230)

The ACMP requires that decisions on the siting and approval of energy-related facilities be based, to the extent practicable, on 16 criteria within the energy facilities standard. Lease stipulations and ROPs in place under Alternative C would be effective in reducing conflicts, making the alternative consistent with the statewide standard.

Other criteria within this standard require that facilities be consolidated and sited in areas of least biological productivity, diversity, and vulnerability and where effluents and spills can be controlled or contained (11 AAC 112.230 (a) [3] and [14]). Under Alternative C, ROPs and lease stipulations would be effective in protecting many biologically sensitive areas, although leasing would be permitted in the 213,000-acre goose molting and caribou habitat areas that would be off-limits under alternatives A and B. The NSB CMP also requires that transportation facilities and utilities be consolidated to the maximum extent possible (NSB CMP 2.4.5.2[f] and NSBMC 19.70.050. K.6).

Construction associated with energy-related facilities under Alternative C would also be required to comply with siting standards that apply to all types of development, which are discussed below under Habitats; Air, Land, and Water Quality; and Historic, Prehistoric, and Archeological Resources.

Utility Routes and Facilities (11 AAC 112.240) and Transportation Routes and Facilities (11 AAC 112.280)

These statewide standards require that routes for transportation and utilities be compatible with district programs and sited inland from shorelines and beaches. Utility routes and facilities along the coast must avoid, minimize, or mitigate alterations in drainage patterns, disruption in wildlife transit, and blockage of existing or traditional access.

The NSB CMP contains several additional policies related to transportation and utilities that would be relevant to this analysis. All but one are best-effort policies, and are subject to some flexibility. Transportation development, including pipelines, which would significantly obstruct wildlife migration, is subject to three conditions (NSB CMP 2.4.5.1[g] and NSBMC 19.70.050.J.3.f). Interference with caribou movements would be short term under Alternative C; caribou migrations and overall distribution should not to be affected. Lease stipulations and ROPs in place under Alternative C would effectively reduce conflicts, making the alternative consistent with the statewide standard.

Transportation and utility facilities would be consolidated to the maximum extent practicable. Therefore, there should be no conflict with either NSB CMP 2.4.5.1(i) (NSBMC 19.70.050.J.3.h), which discourages duplicative transportation corridors from resource-extraction sites, or NSB CMP 2.4.5.2(f) (NSBMC 19.70.050.K.6), which requires consolidation of transportation facilities

and utilities. Lease stipulations and ROPs under Alternative C would effectively reduce conflicts, making this alternative consistent with the statewide standard.

The NSB CMP 2.4.6(b) (NSBMC 19.70.050.L.2), under the category of Minimization of Negative Impacts, requires that alterations to water features associated with transportation and utilities be minimized, and that periods critical for fish migration be avoided. Lease Stipulation K-6, in particular, would be effective in ensuring compliance with this standard.

Sand and Gravel Extraction (11 AAC 112.260)

The ACMP statewide standards indicate sand and gravel may be extracted from coastal waters, intertidal areas, barrier islands, and spits when no practicable noncoastal alternative is available to meet the public need (6 AAC 80.110[b]). Substantial alteration of shoreline dynamics is prohibited (NSB CMP 2.4.5.1[j] and NSBMC 19.70.050.J.3.i). Constraints may be placed on extraction activities to lessen environmental degradation of coastal lands and waters (NSB CMP 2.4.5.2[a] and [d] and NSBMC 19.70.050.K.1 and 4). Substantially more gravel could be required under Alternative C than under the other alternatives, but ROPs and lease stipulations (See Table 2-2 in Chapter 2) would be effective by placing restrictions on gravel mining locations and thus reducing conflicts to ensure compliance with this standard and the NSB policies.

Subsistence (11 AAC 112.270)

The statewide standard for subsistence indicates a project within a designated subsistence use area must avoid or minimize impacts to subsistence uses of coastal resources. Subsistence uses of coastal resources and maintenance of the subsistence way of life are primary concerns of the residents of the NSB. Under Alternative C, the entire Beaufort Sea coast would be open to leasing. As a consequence, access to subsistence resources could be more limited, leading to a reduction in subsistence hunting and resource use, relative to the other alternatives. Disturbances and oil spills associated with oil and gas activities would have short-term and localized impacts on the TLH caribou and other terrestrial mammals, fish, and birds, and bowhead whales and other marine mammals. The impacts would result in more difficult and somewhat reduced success at subsistence harvests for Barrow, Atqasuk and Nuiqsut hunters. Subsistence-hunter concerns about access to resources, resource disturbance, and resource contamination would be greater than for the other alternatives. Lease stipulations would offer protection to subsistence resources and activities. Surface, air, and foot traffic near the oil fields would be expected to increase more than under the other alternatives, and would potentially displace large numbers of caribou, moose, muskox, grizzly bears, wolves, and wolverines. Roads and pipelines would be constructed to provide for unimpeded wildlife crossings. Based on the analysis of disturbance from oil and gas activities on caribou, potential conflict with the subsistence policies would be greater under Alternative C than under the other alternatives. Although Alternative C would still comply with the statewide standard, the effects on subsistence resources and activities would depend to a great extent on the location(s) of well fields and facilities. For example, development in the caribou calving and insect-relief area north of Teshekpuk Lake would have a notably greater effect than would development in less sensitive areas.

Policy 2.4.3(d) (NSBMC 19.70.050.D) requires that development not preclude reasonable access to a subsistence resource. Onshore pipelines and construction activities could cause disruptions to subsistence caribou harvests from access and movement conflicts, but effects are expected to be short term. Where access is reduced or restricted, development can occur only if no feasible or

prudent alternative is available, and is then subject to the conditions of best-effort policies. Conflict with these standards and policies would be somewhat greater under Alternative C than under other alternatives.

Several important NSB CMP policies relate to effects on subsistence resources. The NSB CMP policy 2.4.3(a) (NSBMC 19.70.050.A) relates to extensive impacts to a subsistence resource that are likely and cannot be avoided or mitigated. In such an instance, development must not deplete subsistence resources below the subsistence needs of local residents of the NSB. Policy 2.4.5.1(a) (NSBMC 19.70.050.J.1) addresses development that would likely result in decreased productivity of subsistence resources or their ecosystems. Temporary reductions in subsistence resources and changes in subsistence resource-distribution patterns could occur as a result of disturbance from seismic surveys, aircraft and vessel traffic, drilling activities, and construction activities (offshore dredging, pipeline construction, structure placement and onshore pipelines, and construction of support bases, and roads).

The Alternative C development scenario predicts that there would be an onshore pipeline for oil delivery to the TAPS and that a pipeline spill could potentially contaminate the Colville River. A spill entering the Colville River potentially could affect subsistence harvest by reducing fish populations, disrupting subsistence-fishing activity, and curtailing the subsistence hunt by tainting resources or causing subsistence users to perceive them as tainted (**section 4.5.12, *Subsistence***). However, the number of sizable oil spills estimated for Alternative C would still be small. It is anticipated that the potential for effects from spills and associated clean-up activities would be greater under Alternative C than under the other alternatives, but that the impact on subsistence resources and harvest patterns would be minor.

Conflict with these policies would be possible during the exploration, development, and production phases but would more likely during development and production. Under Alternative C, ROPs and lease stipulations designed to protect subsistence resources and to establish procedures and advisory bodies to address subsistence concerns would effectively minimize policy conflicts. Therefore, Alternative C should be consistent with the statewide standard.

Habitats (11 AAC 112.300)

The statewide standard for habitats contains management measures specific to nine areas: offshore areas; estuaries; wetlands; tideflats; rocky islands and seacliffs; barrier islands and lagoons; exposed high-energy coasts; rivers, streams, and lakes (including associated floodplains and riparian management areas); and important upland habitat. The NSB CMP contains a district policy that reiterates the applicability of the statewide standard (NSB CMP 2.4.5.2[g] and NSBMC 19.70.050.K.7), plus several others that augment the overall policy or can be related to activities within a specific habitat. Under Alternative C, no sensitive habitat areas in the planning area would be excluded from leasing, in contrast to Alternative A, which would exclude 600,000 acres, Alternative B, which would exclude 213,000 acres, or Alternative D, which would defer leasing on approximately 211,000 acres (Teshekpuk Lake) from oil and gas leasing. However, applicable ROPs and lease stipulations (See Table 2-2 in Chapter 2) would provide effective protection for birds, terrestrial mammals, and fish and their habitats. Therefore, conflicts with the ACMP standards would be minimized to the extent practicable, and activities under Alternative C would be consistent with the statewide standard.

The ACMP statewide standard for habitats in the coastal zone requires that habitats be managed to avoid, minimize, or mitigate significant adverse impacts to habitat resources. This

policy is supported by an NSB CMP policy requiring that development be located, designed, and maintained in a manner that prevents substantial impacts on fish and wildlife and their habitat, including water circulation and drainage patterns and coastal processes (NSB CMP 2.4.5.2[b] and NSBMC 19.70.050.K.2). In addition, vehicles, vessels, and aircraft that are likely to cause significant disturbance must avoid areas where species that are sensitive to noise or movement are concentrated, at times when such species are concentrated (NSB CMP 2.4.4 [a] and NSBMC 19.70.050.I.1). Some disturbances associated with exploration and development would be mitigated by lease stipulations placed on permits. Alternative C ROPs and lease stipulations would effectively reduce potential conflicts, and the activities would be consistent with the statewide standard, assuming the AO would be cognizant of the NSB requirements when determining the appropriate requirements of the performance-based lease stipulations and ROPs.

Oil and gas development activities could affect several of the habitats identified in the statewide standard, including lagoons, wetlands, rivers, lakes, and streams. Therefore, onshore-development activities would need to be designed and constructed to avoid, minimize, or mitigate significant adverse effects.

It is expected the caribou of the CAH and TLH would be disturbed and their movements delayed along the pipeline during periods of aircraft overflights, but that disturbances would not affect migrations or overall distribution. It is expected that surface, air, and foot traffic near the oil fields would be greater under Alternative C than under the other alternatives, and could displace some large mammals, though not enough to substantially affect North Slope populations. The NSB CMP policy 2.4.6(e) (NSBMC 19.70.050.L.5) emphasizes that roads and pipelines must provide for unimpeded wildlife crossing and provides a set of guidelines and an intent statement specifically to implement the policy.

Rivers, lakes, and streams are managed to avoid, minimize, or mitigate significant adverse impacts to natural water flow; active floodplains; and natural vegetation within riparian management areas. Pipeline and road construction, including gravel extraction, could affect these waterways and would need to be conducted in a manner that would ensure the protection of riverine habitat and fish resources. Gravel extraction also is regulated under policies that are described in Section 11 AAC 112.260. The ROPs and lease stipulations in place under Alternative C would effectively reduce conflicts, and would be consistent with the statewide standard.

Air, Land, and Water Quality (11 AAC 112.310)

The air, land, and water quality standard of the ACMP incorporates by reference all the statutes pertaining to, and regulations and procedures of, the ADEC. The NSB reiterates this standard in its district policies and emphasizes the need to comply with specific water and air quality regulations in several additional policies. The NSB policies (NSB CMP 2.4.4[k] and NSBMC 19.70.050.I.11) address water quality issues; development must comply with the conditions of the best-effort policies (NSB CMP 2.4.5.1[e] and NSBMC 19.70.050.J.3.d). Under Alternative C, there could be some short-term conflict with these policies due to potential oil spills, which would likely be more frequent under Alternative C than under the other alternatives. However, the ROPs and lease stipulations (See Table 2-2 in Chapter 2) in place under Alternative C would effectively reduce conflicts, and the alternative would be consistent with the statewide standards.

Some discharges and emissions would occur during exploration and development, and the NSB CMP policy 2.4.4(c) (NSBMC 19.70.050.I.3) requires that these emissions comply with all state and Federal regulations, which is consistent with the statewide standard.

Discharges of muds, cuttings, and drilling fluids are regulated closely. Formation water produced from the wells along with the oil is regulated by the USEPA. The Alaska Oil and Gas Conservation Commission has primacy for this program. Some wastes are disposed through the annulus of producing wells, an activity is exempt from the Underground Injection Control program. However, the AOGCC also regulates this practice for the State of Alaska. Surface disposal of drilling wastes would require a solid waste permit from ADEC.

Because discharges of muds, cuttings, and drilling fluids are closely regulated, no conflict is anticipated with the statewide standard or NSB CMP policy 2.4.4(d) (NSBMC 19.70.050.I.4), which requires that industrial and commercial development be served by solid waste disposal facilities that meet state and Federal regulations. There would be no inherent conflict between the proposed activities of Alternative C and the ACMP water-quality provisions.

Air quality also must conform to Federal and state standards (11 AAC 112.310, NSB CMP 2.4.3[i] and 2.4.4[c], and NSBMC 19.70.050.H and I.3). The analysis of air quality effects under Alternative C in **section 4.5.1, *Air Quality*** indicates that conformance is anticipated, and no conflict between air quality and coastal policies should occur.

Historic, Prehistoric, and Archaeological Resources (11 AAC 112.320)

The ACMP statewide standard requires that coastal districts and appropriate state agencies identify areas of the coast that are important to the study, understanding, or illustration of national, state, or local history or prehistory, including natural processes.

The NSB developed additional policies to ensure protection of its heritage. The NSB CMP 2.4.3(e) (NSBMC 19.70.050.E) requires that development that is likely to disturb cultural or historic sites listed on the National Register of Historic Places; sites eligible for inclusion in the National Register; or sites identified as important to the study, understanding, or illustration of national, state, or local history or prehistory shall 1) be required to avoid the sites; or 2) be required to consult with appropriate local, state and Federal agencies and survey and excavate the site prior to disturbance. The NSB CMP 2.4.3(g) (NSBMC 19.70.050.G) also requires that development not disturb newly discovered historic or cultural sites prior to an archaeological investigation. It is likely that new cultural and paleontological sites would be discovered under Alternative C. No conflicts with these policies would be expected, however, since lease stipulations and ROPs would require an inventory of traditional use sites prior to conducting any activities. Therefore, Alternative C would be consistent with the statewide standard.

Traditional activities at cultural or historic sites also are protected under the NSB CMP 2.4.3(f) (NSBMC 19.70.050.F) and 2.4.5.2(h) (NSBMC 19.70.050.K.8). As noted in the discussion of policies related to subsistence, the latter is a best-effort policy that requires protection for transportation to subsistence use areas as well as cultural use sites. No conflict with these policies would be expected.

Effects of Abandonment and Rehabilitation

Land ownership would not be affected by abandonment and rehabilitation. Upon completion of abandonment and rehabilitation, land uses and management could return to as near the original condition as practicable.

Effects of Spills

Because of the interrelated nature of the ACMP and NSB CMP policies, the potential effects of spills were addressed with the effects of disturbances under each major policy area above.

It is expected that disturbances and oil spills associated with oil and gas activities would cause short-term and localized impacts from disturbance and oil spills to the TLH caribou and other terrestrial mammals, fish, and birds, and bowhead whales and other marine mammals. These impacts would likely be greater under Alternative C than under the other alternatives, as would subsistence hunter concerns about access to resources and resource contamination. The greater degree of impacts would result from opening additional area to leasing in caribou, waterfowl, and fishing areas, and because the expected level of development would be higher. Conflicts with ACMP and NSB CMP policies related to effects on subsistence resources resulting from periodic disturbance and oil spills would be possible, but no resource would become unavailable, undesirable for use, or experience overall population reductions. Implementation of ROPs and lease stipulations would therefore ensure that Alternative C would comply with coastal management policies and standards of the ACMP and NSB CMP. Combined oversight by the BLM, the ADNR, and the NSB, under the guidance of their respective standards, would be sufficient to deal with any potential conflict that could arise between Alternative C and the policies addressed in this section.

4.5.15.3 Effectiveness of Stipulations and Required Operating Procedures

Lease stipulations and ROPs referred to under each of the Coastal Zone Policy standards discussed above should be sufficient for Alternative C to achieve compliance with ACMP and NSB CMP policies and standards. While it is expected that there could be land use and CZM policy conflicts over the life of the alternative development scenario, any such conflicts should be short term and subject to resolution. Conflicts, should they occur, would most likely result from oil and gas development activities interrupting subsistence activities, but enforcement of applicable lease stipulations and ROPs would be effective in minimizing the conflicts and quickly return the development to compliance with policies and standards.

4.5.15.4 Conclusion

Under Alternative C, conflicts could occur with specific statewide standards and NSB CMP policies related to potential user conflicts between development activities and access to subsistence resources. Conflicts are possible with the NSB CMP policy related to effects on subsistence resources resulting from periodic disturbance and oil spills, but no resource would become unavailable, undesirable for use, or experience significant overall population reductions. These effects would occur in the unlikely event of spilled oil contacting subsistence resources and habitats and the activities associated with oil-spill cleanup. However, the ROPs and lease stipulations in place would be effective in reducing conflicts, and Alternative C would be consistent with ACMP standards.

In summary, it is expected that effects to terrestrial mammals would occur, but that there would not be high impacts to populations. Small numbers of terrestrial mammals would be lost due to the increase of small, chronic crude oil and fuel spills, but populations would be expected to recover within 1 year. Arctic fish populations would experience minor effects. Disturbance and displacement effects and oil-spills risks would be expected for birds. Bowhead whales would be expected to experience short-term, non-lethal effects. Effects to seals and polar bears would be short term and localized, with no substantial effects to populations.

Because these effects would be spread over several decades, the biological analyses expect moderate overall effects on resource populations. Therefore, effects on subsistence harvest patterns in the communities of Barrow, Atqasuk, Anaktuvuk Pass, and Nuiqsut as a result of impacts from disturbance and oil spills should be moderate, and would not make any subsistence resource unavailable or undesirable for use, nor would overall population reductions be expected.

4.5.16 Recreational Resources

4.5.16.1 Activities Not Associated With Oil and Gas Exploration and Development

Under Alternative C, impacts to recreation resources from on-the-ground management activities such as archeological collection efforts, field camps, survey work, and overland moves would be very similar to those that would occur under Alternative A.

Temporary structures, vehicles, noise from generators, aircraft, human presence, and associated activity would all have minimal short-term effects on the experience of solitude, naturalness, or primitive/unconfined recreation in the planning area. As under other alternatives, these short-term impacts would be confined primarily to the activity site viewshed or noiseshed within approximately ½ mile in any direction of the activity (500 acres). Approximately 2,000 to 3,000 acres would be affected at a time. All of the identified non-oil and gas activities would be transitory and short term; the likelihood of recreationists encountering them in any given location in the 4.6 million acre planning area would be small. If such activities were encountered, the recreation experience and opportunity for solitude on the North Slope would be diminished somewhat. Depending on the activity, there may be some increased likelihood of an encounter with recreationists because of the propensity to concentrate on major rivers and coastal areas.

A longer-lasting impact would be trails resulting from overland moves. These trails are created by vehicles compacting snow and dead vegetative matter that in turn results in the greater availability of moisture and nutrients for underlying vegetation the following growing season. These trails do not necessarily develop over the entire route of an overland move, but when they do they can be very detectable from the air for 2 to 5 years. They usually are difficult to recognize from the ground. Another impact along these trails that has occurred in the past is vegetation actually being damaged or broken or the tops of tussocks being scraped off. Current operating procedures make this an infrequent problem, but one that can occur in conjunction with these trails. Because overland moves would be relatively constant from year to year and generally follow the same route(s), several hundred to several thousand miles of intermittent trail in some phase of recovery (attributable to overland moves) could be visible from the air during any one summer season. Though still relatively short term in nature, the linear nature

of these trails would emphasize the presence of man, which would reduce the sense of naturalness and unconfined primitiveness to a small degree.

Although there are no formal designations of wilderness or wild and scenic rivers in the planning area, and none are anticipated at this time, none of the identified non-oil and gas activities would diminish requisite wilderness and wild and scenic river characteristics sufficiently to preclude such designations in the future.

4.5.16.2 Oil and Gas Exploration and Development Activities

Effects of Exploration

Under Alternative C, seismic work would occur throughout most of the planning area. This work would occur in winter using all-terrain ground vehicles supported by light aircraft. Mobile seismic camps would consist of a train of trailer sleds pulled by tractors. These moving camps and associated noise and activities would result in a short-term effect on the primitive setting of the planning area and a loss of solitude and naturalness. The effects would be confined primarily to the activity site viewshed or noiseshed, or within approximately ½ mile in any direction. As many as five seismic operations could take place in a season, temporarily affecting approximately 2,500 acres. The potential effect on recreation opportunities and experience would be minimized by the fact that very little recreation takes place in the area.

A longer lasting impact would be trails resulting from seismic survey operations. Unlike overland moves, seismic operations do not follow the same routes every year and the number of miles of survey line run can vary greatly from year to year. In some years, no surveys would occur. As with trails created by overland moves, these trails do not necessarily develop over the entire survey route; they would be visible for about 2 to 5 years. However, oil and gas scenarios state that approximately 250 miles (6,060 acres) of line would be surveyed using 2-D seismic methods, while approximately 10,560 miles (98,880 acres) of line could be surveyed annually using 3-D seismic methods, potentially resulting in several thousand miles of trails. Mobile camp trails could add another 840 miles (3,056 acres) of trails. Although some of the camp train route could be outside of the planning area and could overlap survey line miles. The number of miles of trail visible would decline as this phase of exploration slows. Though relatively short term in nature, the linear nature of these trails would emphasize the presence of man, which would reduce the sense of naturalness and unconfined primitiveness to a small degree.

Approximately 210 exploration and delineation wells are anticipated under Alternative C. However, due to the limited number of drill rigs available, it is anticipated that no more than eight wells would be drilled at any one time. Drilling would occur over several seasons, primarily using ice pads, roads, and airstrips. Temporary on-site location of structures (e.g., drill rigs); noise from sources such as generators, vehicles, aircraft; human presence; and associated activity would all have short-term impacts on solitude, naturalness, and primitive/unconfined recreation experiences. Effects would be expected to be greatest within a 2-mile radius of the drill site, or an area of approximately 8,000 acres per site. Accordingly, under Alternative C, there would be a temporary loss of solitude, naturalness, or primitive/unconfined recreation over an area of approximately 64,000 acres during any given year, which would be equivalent to about 1.4% of the planning area. The potential effects on recreation opportunities and experience would be minor.

In addition to the short-term impacts that result from ongoing exploratory drilling operations, an accumulating summer-season visual concern exists as a result of the greening of vegetation

under vacated ice pads, airstrips, and roads. This direct impact to the area's naturalness would be a result of the same conditions that create green trails, the greater availability of moisture and nutrients as ice or compacted snow melts. This greening of the vegetation does not necessarily develop wherever ice pads are constructed or snow is compacted but when it does, it can be very noticeable from the air for 2 to 5 years and somewhat less noticeable from the ground. Another impact at these sites would be vegetation actually being damaged or broken, especially along the perimeter of a pad or edge of a road. Exploratory drilling operations and ancilliary facilities i.e. 210 ice pads (6 acres each), 40 airstrips (11 acres each) and 7,182 miles of ice roads (3 acres/mile) would result in as many as 23,463 acres that would be in a various state of recovery from these impacts.

Exploration wells that do not indicate the presence of hydrocarbons in developable quantities will be plugged and abandoned leaving nothing more than possibly a mound of dirt expected to be no larger than a square foot on the lands surface. Wells that show potential may be "suspended," and capped with what is known as a "Christmas tree" at the surface, especially if the well might be used again for possible oil production. These are essentially a permanent impacts (less than 6 feet high), but almost unnoticeable from several hundred feet away.

Effects of Development

Up to 37 production pads, and 182 miles of pipeline that extend beyond the production area are anticipated under Alternative C. While the intensity of impacts would be greatest during actual construction and development of these facilities, remaining structures, human presence, and associated activity and noise all would have impacts on the experience of solitude, naturalness, and primitive/unconfined recreation opportunity during the life of the field. Because production could occur for 10-50 years, impacts would be long term. These long-term impacts are expected to be greatest within 2 miles of a pad or staging area site (or an area of about 8,000 acres).

There would be little if any pipeline associated on-the-ground activity, except during construction and repair. Long-term impacts to recreation values from pipelines would be expected to be minimal beyond about ½ mile. This equates to about 640 acres per mile of pipeline. Under this alternative, there would be a long-term loss of solitude, naturalness, or primitive/unconfined recreation opportunity over an area of up to 412,480 acres (i.e., [8,000 acres/pad x 37 pads] + [640 acres/mile x 182 miles of pipeline]). In addition, it is estimated that long-term surface (i.e. 2 miles from footprint of staging and CPFs) disturbance and consequently impacts to primitive recreation from four staging areas (50 acres each) and seven CPFs (90 acres each) including pads, roads, airstrips, gravel pits, and infield gathering pipelines and associated infield gravel roads (370 miles) would impact 341,900 acres (i.e. [9,300 acres/staging area x 4 staging areas] + [9,700 acres/CPF x 7 CPFs] + [640 acres/mile of road x 370 miles]). These impacts combined (754,380 acres), would be equivalent to about 16.4% of the planning area. Short-term, routine/daily inspection flights also would impact solitude and naturalness along the length of all pipelines as long as they are in use. The potential effect on recreation opportunities and experience would be greatest for development activities because it would entail year-round activity and would thus continue during the summer when most recreational activity in the planning area occurs. Therefore, the effects to recreation use would not be considered a great impact, because they would impact such a small portion of the planning area (16.4%) and because there is such a small amount of recreation use in the area. The actual effects would depend greatly on where development fields were located relative to major watercourses and the Beaufort Sea coast.

Effects of Abandonment and Rehabilitation

While abandonment and rehabilitation activities occurred, small number of recreational users in the area of rehabilitation could have their wilderness experience diminished by noise, marred views, and disturbance to animals which they have come to observe (bird-watchers) or harvest (hunters). However, over the long term, these efforts would minimize and impacts to recreation use would likewise be minimized.

Effects of Spills

Most spills would be confined to a pad. Spills not confined to a pad usually are confined to the area immediately around the pad or pipeline. Therefore, effects on solitude, naturalness, or primitive and unconfined recreation opportunities resulting from spills likely would be confined to the same area described above as impacted by the development.

A large spill that would reach a river, especially the Colville River, and move rapidly downstream would have substantial short-term (and possibly long-term) impacts on recreation values.

Effects to Wilderness and Wild and Scenic River Values

None of the identified non-oil and gas activities would diminish requisite characteristics sufficiently to prevent wilderness or wild and scenic river designations in major portions of the planning area in the future.

Potential wilderness values of naturalness and outstanding opportunities for solitude and primitive, unconfined recreation experiences would be affected by long-term development of petroleum resources on as much as 16.4% of the planning area under Alternative C, about 3% to 4% greater than that similarly affected under Alternative A and B. In addition, portions of the area could be explored, resulting in lesser residual effects that would reduce wilderness values. Despite the lost values, over 3.9 million acres, almost 84%, of the planning area, would likely retain substantial wilderness values.

The "outstandingly remarkable values" that support Wild and Scenic River eligibility for the Colville River include recreation, wildlife viewing, geology, and archeology upstream from Umiat, and paleontology and wildlife from Umiat to Nuiqsut. Only a small portion of the Colville River would experience effects to these values from activities associated with Alternative C, primarily from an expected pipeline crossing of the river in an as yet undetermined location. Specified buffer areas would provide substantial protection for the Colville and other rivers, except in the area very near the pipeline crossing. Although pipeline crossings are discouraged in designated Wild and Scenic River areas, they are permissible, when unavoidable, if measures to minimize effects on the river's outstandingly remarkable values are utilized.

Wild and Scenic River designation is not planned or proposed for the Colville River, as noted in **section 3.4.6.3**, but the applicable lease stipulations and ROPs would preserve most, if not all, of the character and values that could qualify the river for designation in the future, if local and state political sentiments should ever determine designation to be favorable. A potential pipeline would not disrupt the requisite "free flowing" nature of the river and, to the degree possible, it would be sited to avoid the areas specific to the "outstandingly remarkable values" noted above. Selection of a river crossing location for the pipeline would require a permit from

BLM, which would afford an opportunity for more detailed review of effects on the Wild and Scenic River eligibility of the Colville River.

Commercial Gas Development

Because a gas pipeline would likely be buried and because little recreation occurs in the planning area in the winter when construction would primarily occur, there would be very little impact to recreation from gas development. The exception might be if gas development prompted some development that would not occur if only oil could be developed. In those cases, impacts would be similar to those associated with oil development. Because more land would be available for such development under Alternative C than under the other alternatives, it is most likely to impact recreation.

4.5.16.3 Effectiveness of Stipulations and Required Operating Procedures

Although the lease stipulations and ROPs do not specifically address recreation activities, and there is no intent by BLM to consider designation of wilderness or wild and scenic rivers in the planning area, many of the performance-based lease stipulations and ROPs required for development under Alternative C would serve to protect recreation values in the area. For example, certain areas would be excluded from leasing or surface development, and several ROPs and lease stipulations address protection of subsistence values and wildlife in the planning area. Surface activity and facility development restrictions would help to minimize potentially damaging activity in and near creeks, rivers, and lakes. Since wildlife viewing, big game hunting, and boating are the primary activities that attract recreationists to the planning area, these lease stipulations and ROPs would also help protect and preserve recreation values.

4.5.16.4 Conclusion

There would be approximately 2,000 to 3,000 acres in temporary effects on recreation values from activities other than oil and gas exploration and development. Short-term (temporary) disturbance from ongoing oil and gas exploration activities would impact approximately 107,996 acres. This is the same as under Alternative A. The “greening” of vegetation resulting from ice pads, roads, airstrips, and compacted snow would impact an additional 23,463 acres. Most of the combined 131,459 acres could be in a various state of recovery from the “greening” effect. Seismic operations would result in temporary impacts to recreation use over many hundreds of miles of trails and noise and other disturbance produced by seismic operations. Short-term impacts such as green trails and pads, disturbance from noise, aircraft and other on-going activities would not accumulate.

Oil and gas development would result in the long-term loss of solitude, naturalness, or primitive/unconfined recreation opportunities over an area of approximately 754,380 acres (or 16.4% of the planning area) for the life of production fields and pipelines. The area subject to recreation impacts would be approximately 180,400 acres greater than the impacts on recreation under Alternative A. Lease stipulations to mitigate for these impacts would be similar for both alternatives.

4.5.17 Visual Resources

4.5.17.1 Activities Not Associated With Oil and Gas Exploration and Development

Under Alternative C, impacts to visual resources would result from on-the-ground management activities, such as archaeological collection efforts, field camps, survey work, overland movements, and hazardous and solid material removal and remediation activities and would be similar to Alternative A. The level of non oil and gas activity may increase under this alternative, as a result of general increased interest in the area generated by the potential of more oil and gas development.

Temporary structures (e.g., sleds, tents), vehicles (e.g., Rolligons, tractors), aircraft, human presence, and associated activities would have some minimal short-term impacts on visual resources or scenic quality by creating a contrast to the line, color, and texture of a primarily horizontal natural landscape. The colors of structures and equipment would contrast the white color of the snow-covered landscape and the various hues of greens and browns, and the smooth texture of the facilities would contrast the varied textures of the windswept terrain and the irregular texture of vegetation. Non-oil and gas activities would need to occur within the Foreground-Middleground Zone of the viewshed in order to attract the attention of the casual observer.

A longer-lasting impact would be trails, sometimes referred to as "green trails", resulting from winter overland moves. Between 20 and 60 trains comprised of one to six vehicles and attached sleds could engage in overland travel each year. These trails form when vehicles compact snow and dead vegetative material, resulting in a greater availability of moisture and nutrients for underlying vegetation the following growing season. Visible trails would not necessarily develop over the entire route of the overland move. Vegetation could be damaged along these trails and the tops of tussocks could be scraped off, although current operating procedures would ensure that such damage was an infrequent problem. Trails would be visible for about 2 to 5 years, but some trails may be visible for longer periods of time. However, because they visually modify existing vegetation, rather than introducing something foreign into the viewshed, trails would not produce much contrast to line, form, or texture. The color contrast would be minimal from ground view because of the natural variation in hue, and would be almost nonexistent from more that a few hundred feet away.

4.5.17.2 Oil and Gas Exploration and Development Activities

Effects of Exploration

Under Alternative C, impacts to visual resources from seismic surveys would be the same as Alternative A. The discussion is repeated here for convenience.

Five seismic surveys would occur. Seismic work would occur in the winter using cat trains with low-ground-pressure vehicles supported by light aircraft. Seismic crews would be housed in mobile camps consisting of a train of trailer sleds pulled by tractors along different trails. These moving camps and associated activities would result in short-term impacts on visual resources and the scenic quality of the area by creating color contrast between the vehicles and trailers and the predominantly white background of the snow-covered landscape. These impacts would be confined primarily to the activity-site viewshed.

Trails resulting from seismic survey operations would result in a longer-lasting impact to visual resources. Unlike overland moves, seismic operations would not follow the same routes every year, and the number of miles of survey line could vary greatly from year to year. In some years, no surveys would occur. Like trails caused by overland moves, trails caused by seismic operations would not necessarily develop over the entire survey route, but where present would be visible for about 2 to 5 years, but some trails may be visible for longer periods of time. Approximately 250 miles (6,060 acres) of lines would be surveyed using 2-D seismic surveys, while approximately 10,560 miles (98,880 acres) of lines could be surveyed during each 3-D seismic survey, potentially resulting in several thousand miles of trails. Mobile camp trails could add another 840 miles (3,056 acres) of trails. Because trails visually modify existing vegetation, they would not produce much contrast to line, form, or texture. The color contrast would be minimal from ground view because of the natural variation in hue, and would be almost nonexistent from more than a few hundred feet away.

Approximately 210 exploration and delineation wells would be drilled under this alternative, 59 more than under Alternative A and 40 more than Alternative B, and 17 more than Alternative D. Given the limited number of drilling rigs available, however, no more than eight drilling rigs would likely be operating at any one time. Drill rigs (average height of 208 feet) would introduce strong vertical lines into a predominantly horizontal landscape. Because they are painted red, most drill rigs would also produce a strong visual contrast to the white background of the snow-covered landscape. Winter drilling requires lighting, which would create a visual contrast against the dark night sky. Drill rigs, because of their height, could be seen and attract the attention of the casual observer if they were located within the Foreground-Middleground Zone and Background Zone.

In addition to the impacts that would result from ongoing exploratory drilling operations, the greening of vegetation under vacated ice pads, ice airstrips, and ice roads would cause impacts to visual resources during the summer. This greening of vegetation would be caused by the same conditions that create "green trails" — a greater availability of moisture and nutrients as ice or compacted snow melts. However, greening of vegetation would not necessarily occur everywhere ice facilities were constructed or snow was compacted. There would also be a "ring effect" around ice pads, ice airstrips, and ice roads caused by the death of vegetation adjacent to these snow and ice structures. Winter facilities inclusive of 210 ice pads (6 acres each), 40 airstrips (11 acres each), and 7,182 miles of ice roads (3 acres per mile) would result in as many as 23,463 acres that would be in various states of recovery from greening and ring effects under Alternative C (16,768 acres in Alternative A; 20,022 acres in Alternative B; and 20,202 acres in Alternative D). Because greening and ring effects visually modify existing vegetation, they would not produce much contrast to line, form, or texture. The color contrast would be minimal from ground view because of the natural variation in hue, and would be almost nonexistent from more that a few hundred feet away.

Dry exploration wells would be cut off and plugged below ground level and temporally leave only a small area barren of vegetation while exploration wells with production potential would leave behind a marker pipe (also known as a Christmas tree), which would likely be less than six feet tall and no larger than a square foot on the surface. This marker pipe would essentially be a permanent impact, but would be almost unnoticeable from a distance of several hundred feet.

Effects of Development

Production rigs (two with an average height of 208 feet) would introduce strong vertical lines into a predominantly horizontal landscape. Because they are painted red, most drill rigs would also introduce strong contrast to the natural browns landforms and greens of the vegetation. In addition, burn-off flares and general work lighting would contrast against the dark night sky. Drill rigs, because of their height and color, could be seen and dominate the attention of the casual observer if they were located within the Foreground-Middleground Zone and Background Zone.

It is estimated that long-term surface disturbance from four staging bases (50 acres each), seven pump stations (20 acres each) and seven CPFs (90 acres each) would impact 970 acres (650 acres in Alternative A; 810 acres in Alternative B; and 810 acres in Alternative D). These facilities would introduce strong vertical lines from buildings into the landscape of predominately soft horizontal lines. There would also be a visual contrast between the simple, regular form of the buildings and the complex, irregular forms of the vegetation. Colors of buildings and materials would be in contrast with the greens, browns, and blues of vegetation and water bodies. Some of the buildings could be up to three stories in height above the tundra, and would attract and dominate the view of the casual observer if located within the Foreground-Middleground Zone.

Production pads (32 at 10 acres each), 320 miles of infield roads (2,480 acres), seven airstrips (11 acres each), 16 gravel pits (50 acres each), and 320 miles of infield gathering pipelines (972 acres) would impact 4,649 acres (2,818 acres in Alternative A; 3,664 acres in Alternative B; and 4,538 acres in Alternative D). The gravel pads, airstrips and infield roads would generally be only 3 to 5 feet above the surrounding green tundra, and would be relatively unnoticeable beyond a few thousand feet. Infield gathering pipelines (4-10 inches in diameter) would introduce shiny and smooth horizontal lines into a natural landscape but would be associated with other facilities within the disturbance area. Disturbance associated with gravel sites from borrow pits or below ground bedrock would generally occur below the ground surface, with only stockpiled materials being visible aboveground. While these sites could be large in size or footprint, very little material would remain as stockpile at any one time. Gravel mine sites from above ground bedrock locations may produce visual impacts if material is removed from rock outcrops within the planning area. This mining activity would change the form of the natural landscape and may be visible from the Foreground-Middlegound Zone.

It is anticipated that as many as 182 miles of sales oil and main pipelines, impacting up to 551 acres (3 acres per mile), would be constructed under this alternative (162 miles, 491 acres in Alternative A, B and D). There would be no on-the-ground activity associated with sales oil and main pipelines, except during construction and repair. Sales oil and main pipelines (12-20 inches diameter) would introduce shiny and smooth horizontal lines into the naturally irregular brown and green landscape. They would also introduce regularly spaced vertical supports into an irregular horizontal landscape. All pipelines would be elevated at least seven feet above the surrounding tundra, but could be elevated as high as 20 feet above ground level. At these elevations, pipelines would attract and dominate the attention of the casual observer if located within the Foreground-Middleground Zone and Background Zone.

Other facilities associated with development would include bridges and communications towers. If located within the Foreground-Middleground Zone, bridges, because of their contrast with smooth water bodies, and communications towers, because of vertical height above the horizon, would also be likely to attract the attention of a casual observer.

Vehicle traffic on roads during construction and other production activities would create short-term noticeable visual impacts through the creation of dust. Summer vehicle travel off gravel pads and roads would be very limited, but may cause changes color from the natural landscape by causing damage to vegetation and possibly the tundra mat. These changes would be limited to the Foreground-Middleground Zone.

Effects of Abandonment and Rehabilitation

During abandonment and rehabilitation activities, vehicle traffic on roads would create short-term noticeable visual impacts through the creation of dust. Gravel pads and roads may or may not be removed and may or may not be revegetated with native species or other appropriate vegetative materials. Once closure and abandonment activities, including revegetation are completed, the strong contrasts with the surrounding vegetation colors created by structures, such as pipelines and buildings, gravel pads, roads and airstrips, would be eliminated. If gravel is not removed and not revegetated, long-term color contrasts would remain between the gravel areas and the surrounding natural vegetation.

Effects of Spills

Most small spills would be confined to a pad. Small spills not confined to a pad would usually be confined to the limited area immediately around the pad or pipeline, and usually impact less than five acres. With proper containment and clean-up, there would be no new visual impacts associated with small spills estimated to occur 2,503 times over the life of oil and gas activities in the planning areaunder this alternative (1,792 in Alternative A; 2,070 in Alternative B; and 2,287 in Alternative D).

Large spills, estimated to occur three or four times during the life of oil and gas activities in the planning area, would likely reach beyond the gravel pad and enter the environment. Impacts associated with visual resources would be to the surrounding vegetation and result in a contrast in color between the affected vegetation and soil, and the natural landscape.

Commercial Gas Development

Impacts to visual resources associated with surface disturbance and surface facilities for development and production of natural gas infrastructure would be similar to those described for oil development, though there would be no impacts from an oil spill. If natural gas production facilities are associated with existing oil infrastructure there would be some additional visual impacts associated with pipeline offset impacting additional acres if gas is transported on separate aboveground VSMs. If a gas pipeline is buried—considered the more likely scenario—there would be some change in line, color, and texture. These changes would result from the disturbance of irregular, predominately green, rough vegetation to a more regular, brown, smooth area of soil as seen within the Foreground–Middleground Zone. Facilities associated with a compressor station along a gas pipeline would introduce vertical, blocky, colored facilities similar to CPF structures into a predominately horizontal, green, irregular landscape and be visible within the Foreground-Middleground Zone and the Background Zone from some locations. These facilities would impact additional acres. Alternative C would make more lands available for leasing and gas development than the other alternatives and is estimated to have approximately 20 miles more gas pipelines, thus it is likely to impact visual resources more than the other alternatives.

4.5.17.3 Effectiveness of Stipulations and Required Operating Procedures

Although there are no ROPs or lease stipulations specific to visual resources, ROPs and lease stipulations designed to minimize impacts to solid and hazardous wastes; regulate overland moves, seismic work, and exploratory drilling; and regulate facility design, construction, and siting would reduce the visual impacts that would occur under Alternative C. No acres would be unavailable for leasing and development. However, Restricted Surface Occupancy (RSO) stipulations on approximately 1,113,000 acres will help reduce impacts to visual resources by restricting certain activities associated with exploration and oil and gas development (see Map 2-3).

4.5.17.4 Conclusion

Under Alternative C, as many as 11,650 miles of seismic and camp lines will impact 107,996 acres. This is the same as under Alternative A, B and D. Other facilities such as ice roads, pads and airstrips, associated with exploratory drilling would impact up to 23,463 additional acres. Most of the combined 131,459 acres could be in various states of recovery from greening and ring effects. It is anticipated that up to 502 miles of pipelines would be constructed under this alternative, creating surface disturbance of up to 1,523 acres. There could also be approximately 4,647 acres of disturbance associated with gravel pads, roads, gravel sites, pump stations, staging bases, and Central Processing Facilities. Visual impacts associated with this alternative would be approximately 3.0% of the planning area. Approximately 1,113,000 acres would have Restricted Surface Occupancy stipulations.

4.5.18 Economy

4.5.18.1 Activities Not Associated with Oil and Gas Exploration and Development

Impacts of non-oil and gas activities are likely to be the same as those for Alternatives A and B. Recreational river rafting will occur in the planning area, primarily on the Colville River. BLM estimates (Table 4.2-A) up to 22 trips each made by four persons taking place each year. Employment generated by this activity would result from air taxi service and guide service. Neither of these services originate within the planning area. Air taxi services used for Colville River access originate in Bettles, Kotzebue, Fairbanks, and Coldfoot. Guides originate in Bettles, but may also originate from other locales in Alaska outside the North Slope, or may originate outside Alaska entirely (Delaney 2007). Permitted commercial guided activities will result in fees to the Federal government. Operators or guides pay approximately $600 per year for BLM permits. BLM estimates their clients pay $1,200-$1,500 each for a trip.

Other activities such as research or surveys, various ground activities, and aircraft use not related to petroleum are shown in Table 4.2-A, Summary of Selected Non-Oil and Gas Related Management Activities. North Slope Borough residents may be employed in some of these activities, as will be other Alaskans and nonresidents.

4.5.18.2 Oil and Gas Exploration and Development Activities

In Alternative C, activities will begin and proceed in a manner and order similar to Alternative A. The construction, operation, and servicing of facilities associated with oil and gas activities

would also result in increased property tax revenues. Peak production in this alternative is calculated at 70.0 million barrels in 2041, followed by 73.5 million barrels in 2051, 2061, and 2071, and 2081. By these dates, up to 7 central processing facilities will be in operation. In this case, up to 40% more exploration and delineation wells than Alternative A may be drilled as all fields are developed. The year 2021 initiates substantial production for this alternative as well (31.9 MM bbl).

Revenues

Bonus bids of as much as $77.1 million dollars may result from offers on 584,000 acres of previously unavailable land. Exploration, development, and production activities are estimated to generate property tax revenue to the North Slope Borough of about $43 million in 2021, while capital costs will be depreciated as operation continues, lowering property tax over the life of the operation. Other local, state, and Federal revenues are also anticipated to increase under this alternative. The estimated 2045 royalty payments split equally by the State of Alaska and the Federal government exceed $1 billion. State Taxes will be approximately $90 million, and Federal income tax will be over $1 billion. In addition, $606 million in state severance taxes could be generated in 2045. These estimates are based upon average imported crude oil prices in 2005 dollars from the Annual Energy Outlook 2007.

Table 4.5-B Alternative C Revenues (in millions of 2005 dollars)

Alternative /Revenue	Bonus Bids	Royalty		Property Tax		State Tax		Federal Tax		Severence Tax	
Year		2021	2045	2021	2045	2021	2045	2021	2045	2021	2045
C	77.1	325	1,193	43	241	28	90	325	1,023	165	606

Employment

In this alternative we expect 8 exploratory wells each year in four year increments as a lease is explored. Additional fields will also be delineated by exploratory wells ten to thirty years initial activity. Direct employment will be higher than Alternatives A or B, as high as 3400 by 2045 when three CPFs are operating, a fourth under construction, with wells and infrastructure being added. Over the life of all fields, this alternative potentially offers the most employment, as the total numbers of wells, CPFs, staging bases, are highest. Increased indirect employment will result from added capital investment over the life of all fields in this alternative.

Table 4.5-C. Potential Employment for selected years under Alternative C

Tasks/Alternative	Year	Total Direct	Total Indirect	NSB Direct	NSB Indirect
Survey	2008-9	Same as A	Same as A	Same as A	Same as A
Exploratory well drilling	2010-15	240-480	700-1,400	17-34	12-24
CPF, and infrastructure development	2016	500-800	630-1,000	35-56	24-39
CPF operation development well drilling, sale line construction	2017	500-680	Same as A	same as A	Same as A
Pad, development wells road, pipe, 3 CPFs in operation, CPF under construction	2045	1,700-3,400	2,100-4,200	110-240	85-200

Commercial Gas Development

Natural gas development and production from the NPR-A would generate additional employment. Construction of pipelines would provide substantial numbers of construction jobs for the winter seasons of installation. It is likely that a portion of construction workers would reside in the NSB. Once in operation, gas development would not result in substantial increases in employment over that associated with oil production. However, if gas development occurs as oil production is decreasing or ceasing, the addition or shift to gas production may prolong employment from planning area petroleum production. Development would generate additional property taxes and royalty income for the NSB and State, more severance taxes for the state, and additional royalties for the Federal government. To the extent that industry is attracted to bid on leases for their gas rather than oil production potential, gas development opportunities could increase interest and bid amounts at lease sales within Northeast NPR-A, providing additional revenues for the Federal and state governments. Alternative C offers more land for oil and gas leasing than the other alternatives, so it is anticipated to have the most impact on employment and revenues.

4.5.18.3 Conclusion

The revenues and employment generated by oil and gas exploration and development under Alternative C would be greater than under the Alternative A and slighter greater than under Alternatives B and D. Approximately $241 million would be generated in 2045 in property taxes. The annual royalty would be about the same as in Alternative A. The number of jobs created by exploration, development, and production would be 3,800 to 7,600 during 2045. The number of resident jobs generated would be higher than the number generated under Alternative B, 195 to 440 in the same year. The likelihood for disruptions to the harvest of subsistence resources and associated economic impacts would be greater than under the other alternatives.

4.5.19 Public Health

4.5.19.1 Activities Not Associated With Oil and Gas Exploration and Development

Under Alternative C, the effects of non-oil and gas activities and the potential for increased tourism because of interest generated by leasing in the area could all lead to short term disturbances. It is not anticipated that these activities would be substantially more frequent under Alternative C than under Alternative A. Thus, the health effects from activities not associated with oil and gas exploration and development under Alternative C would be similar to those described under Alternative A and B. In general these effects would be temporary and localized. On an individual basis, such events could be highly significant. But because the activities not associated with oil and gas development are expected to be short term, localized, and sporadic, they would not be expected to result in overall population health changes.

4.5.19.2 Oil and Gas Exploration and Development Activities

Effects of Disturbances

Under Alternative C, the public health effects would be similar in nature, but generally greater in magnitude than those anticipated under the other alternatives. Revenue to the NSB and state would be substantially higher under Alternative C than Alternative A. But since the

entire planning area would be available for leasing, including highly sensitive subsistence habitat on and around Teshekpuk Lake, subsistence and sociocultural impacts would be substantially higher. Hunters from Barrow and Atqasuk would be directly affected by development north and west of Teshekpuk Lake, where numerous subsistence camps, cabins, and ice cellars are located. There could be reductions in subsistence harvest success or increased effort, time, risk, and expense involved in order to harvest adequate amounts of subsistence resources. Nuiqsut subsistence users could be affected by increased activity in the northeast portion of the planning area as the Alpine Satellite Development proceeds, and activity farther west could deflect migrating caribou away from other traditional harvest locations, reducing harvest access and success. If oil and gas activities were to divert or deflect the normal migration routes for the TLH caribou, Anaktuvuk Pass subsistence users could suffer a shortage of caribou, their main subsistence resource. A greater expenditure and risk on the part of the subsistence hunters from Anaktuvuk Pass would be required. In the past, when the herd has failed to pass near the community, hunters had to fly to more remote locations in search of subsistence food, increasing community stress and the time necessary for harvest success, as well as reducing the connection with traditional areas (SRBA 2003b). The development proposed for the planning area would require increased staging and overland travel during the winter as well. In summer, there would be increased use of aircraft for supplies, equipment, and crew changes, as compared to the other alternatives. In turn, this would result in an increase in presence of oil industry personnel in the villages and subsistence areas.

1. Diabetes Hypertension, and Associated Metabolic Disorders

As described in **section 4.3.19**, diabetes, hyperlipidemia, and hypertension – collectively termed "metabolic disorders" here, would result if subsistence were displaced from its current contribution to the diet. These disorders are among the primary risk factors for cardiovascular, cerebrovascular, and chronic renal disease. Metabolic disorders are disproportionately common in AI/AN groups compared with the U.S. population. However, because of the high consumption of subsistence foods in communities depending on the planning area, rates of diabetes in the North Slope Inupiat are among the lowest in the U.S., including among non-natives (Naylor et al 2003; Bjerregaard and Jorgensen 2004; Zinman; Murphy et al 1997; Young et al 1992; Bjerregaard, Young et al 2004).

Under Alternative C, impacts to subsistence would be greater than under the other alternatives. With development occurring throughout the region, there would a significantly higher chance of subsistence impacts leading to dietary change. Furthermore, the modernization and acculturation pressures described under **section 4.5.13** would tend to foster a shift toward a 'western' diet (Schraer and Bulkow 1993; Curtis, Kvernmo 2005; Nobman, Ponce et. Al 2005; Condon et al 1994). Since both sociocultural effects and impacts to subsistence are expected to be greater under Alternative C, we would anticipate a stronger trend toward diabetes and related metabolic disorders than in the other alternatives. Increased employment would provide income for subsistence equipment, but this benefit would be offset by the difficulty of balancing work schedules with subsistence activities.

2. Food Insecurity and Hunger

As described in Alternative A, food insecurity and hunger are considered to be severe health problems even before malnutrition or starvation occur. Because it involves the entire planning area and includes critically important subsistence areas, Alternative C would be associated with the highest probability of food insecurity and hunger among all the alternatives. Both food insecurity and hunger would be likely to increase under Alternative C if significant decreases in harvest success occur. The difficulty of replacing subsistence with store-bought foods is apparent when considering the estimated dollar value of harvested resources as reported above.

To our knowledge, there are no cases of severe protein-calorie malnutrition or starvation in Alaska in recent years. This is likely because of the national and state programs such as food stamps and general assistance, as well as kinship and sharing networks, all of which provide a 'safety net.' Under Alternative C, it is not certain whether these programs would be enough to make up for harvest losses if impacts to subsistence were severe. Starvation is felt to be highly unlikely in view of national, state, and NSB support, but malnutrition could occur in the unlikely event of a severe reduction in the availability of subsistence foods.

3. Social Pathology

Social pathology would be higher under Alternative C than the other alternatives (refer to more complete analysis of this problem in **section 4.3.19**). The workforce is anticipated to increase substantially compared with Alternative A; this would be associated with increased flux of workers through the villages near the planning area, leading to greater acculturation and social stresses, as summarized in **section 4.5.13**, as well as the potential for increased illicit drug and alcohol sales. The possible construction of permanent roads linking the planning area with the Alaskan road system, though very unlikely, would add to this problem. Public health studies have documented the general associations between modernization, acculturation stresses in circumpolar Inuit communities, and social pathology (Curtis T, Kvernmo S et al 2005; Bjerregaard 2001; Shepard and Rode 1996; Travis R 1984).

Stress produced by the loss of traditionally important hunting range, and the fear of curtailed ability to continue pursuing a subsistence way of life, food insecurity, and the longer travel distances and more difficult hunting conditions produced by displacement of subsistence resources and hunters by oil infrastructure would also contribute to increases in social pathology, which could become pervasive if impacts were enough to seriously curtail subsistence and undermine kinship and sharing networks. These effects would likely be most intense in Nuiqsut, which lies between the road system and the planning area, but might be experienced by Anaktuvuk Pass, Wainwright, Atqasuk, and Barrow as well as development of the region expands. Interruption of sharing networks, if severe enough, could have effects on other villages as well. Stress produced by the loss of traditionally important hunting range, and the fear of curtailed ability to continue pursuing a subsistence way of life, food insecurity, and the longer travel distances and more difficult hunting conditions produced by displacement of subsistence resources and hunters by oil infrastructure would all contribute to increases in social pathology. Rosemary Ahtuangaruak, a former Mayor, community health aide, and physician's assistant in Nuiqsut, described the link between subsistence and social pathology: When our people can feed themselves, they're very happy. They don't care if they don't have a job as long as they're providing for their families, as long as they have the hope in their mind of the possibility to provide for their families. You take away that hope, and you're going to have many, many people that we lose to the ills of social ills (Rosemary Ahtuangaruak, in MMS 2001).

On the other hand, data from other populations has fairly consistently shown that economic development and increased employment generally have favorable impacts on rates of social pathology. Travis (1987) showed that in Inupiat communities, the increased risk of suicide caused by rapid modernization and acculturation is mitigated to some degree by economically favorable conditions. Haley (2004) found that strong preexisting economic systems helped a North Slope community cope with the rapid economic change brought by development. One study, however, found that in Inupiat communities, increased employment was not always associated with improved well-being, because of the tensions created between work and subsistence (Martin 2005). However, most North Slope residents tend to view employment

opportunities as a positive, particularly if flexibility to allow continued active participation in subsistence can be built into the work schedule.

Overall, the trend toward increases in social pathology would be most dependent on impacts to subsistence traditions, sharing networks, and the degree to which the proposed action results in illicit importation of drugs or alcohol. The stress associated with widespread community fears about the implications of leasing in this area is evident in community testimony, and will likely contribute to social pathology regardless of actual impacts from development in the region. Improved employment and income opportunity would offset these problems to some degree, but overall trends in social pathology would likely mirror the trends toward socio-cultural disruption as described in **section 4.5.13**.

4. Injury

Injury rates tend to parallel social pathology, reflecting alcohol-related injury, suicide, and rates of violence (ANTHC 2006, injury statistics). Under Alternative C, injury rates would tend to parallel the increased social pathology described above. Additionally, the potential for displacement of hunters and subsistence resources could compound this problem, as longer and more difficult hunts would be associated with a higher risk for injury as well.

The public safety system would face additional stresses coping with large numbers of oil workers entering communities and traveling through the region, making it difficult for communities to adequately enforce prohibition laws. Studies in the region have shown a strong association between adequate VPSO support, effective prohibition laws, and decreased injury rates (Wood and Gruenewald 2006).

5. Health Problems related to EPA Criteria Pollutants

Airborne emissions produced by exploration and development under Alternative C are projected to be substantially greater than under the other alternatives (**section 4.5.1**). However, we estimate that the overall contribution of emissions to PSD class II requirements would be small. EPA Criteria Pollutants (NOx, SO_2, $PM_{2.5}$, PM_{10}, ozone, lead, and CO) are associated with a range of acute health effects, including exacerbation of chronic lung disease and asthma, increased risk of cardiac arrhythmias, exacerbation of atherosclerotic coronary artery disease, and excess overall mortality, particularly among vulnerable groups such as young children, elders, and people with chronic illnesses. According to the EPA, $PM_{2.5}$ in particular is associated with "increased respiratory symptoms, such as irritation of the airways, coughing, or difficulty breathing, for example; decreased lung function; aggravated asthma; development of chronic bronchitis; irregular heartbeat; nonfatal heart attacks; and premature death in people with heart or lung disease" (EPA 2005).

Current air quality assessments on the North Slope are based on scientific judgment and limited modeling. Both EPA and the State of Alaska have established legal limits for air pollution based on scientific evidence, known as Ambient Air Quality Standards, to protect public health, including the health of sensitive populations such as asthmatics, children, and the elderly. However, according to EPA analysis and several independent studies, substantial health effects accrue at even levels below NAAQS standards, down to ambient levels (Ostro et al 2006; USEPA 2006b). The health effects include higher overall mortality rates and higher loss of 'quality adjusted life years,' a measure which takes into account time lost from illness. From the standpoint of the North Slope population, one of the most important findings of these data is that the impacts fall disproportionately to vulnerable populations (elderly, very young, and people with chronic illnesses. Given the baseline health disparities described in **section 3.4.10**, North Slope communities would face substantial risk from increased particulate emissions, even

if air quality continued to meet NAAQS standards. The state of Alaska, however, has not yet adopted a standard for $PM_{2.5}$, for which the EPA established regulatory criteria more recently. The deadline for the state to adopt new $PM_{2.5}$ standards is December 2007. Consequently, there are no data available for $PM_{2.5}$ levels on the North Slope.

The NSB has expressed strong concern that the models used to predict air quality on the North Slope have not been adequately validated, particularly in view of the arctic climate conditions. The NSB and AI-TC have further asserted that, because of the health disparities and vulnerabilities in North Slope villages (including the high prevalence of certain cancers and pulmonary disease, as described in **section 3.4.10**), it is critically important to establish a scientifically robust monitoring program to validate the current predictions.

Given that development would occur throughout the planning area, the increased emissions under Alternative C could result in a greater risk of exacerbation of chronic pulmonary disease, as well as cardiovascular and pulmonary mortality among vulnerable groups. However, occasional exposure to acute low air-quality events is more likely than chronic exposure to poor air quality. Due to the distance of potential development from most population centers, substantial reductions in village air quality is unlikely.

6. Health Problems Related to Other Contaminants

Under Alternative C, development could occur throughout the planning area, including much of the most important subsistence range in the North Slope region. Emissions would be greater than under the other alternatives because of the greater extent of exploration and development-related activities. Oil spills are another route through which contaminants could contact the human population, either directly or through pollution of air, water, and subsistence resources. North Slope residents have expressed concern that development in the Teshekpuk Lake region would pose a particular danger because of its proximity to resources and popular hunting areas.

Public health data support the link between contaminants produced by oil development, and the risk of cancer, endocrine disruption, and cognitive disorders (Jacobsen et al 1996; Arctic Monitoring and Assessment Program 2003; Cone 2005). Data from other communities in which the "total petroleum hydrocarbons" concentrated in water (from air and waterborne sources) has documented a correlation between proximity to oil and gas exploration and production and health outcomes, including cancer and miscarriages (San Sebastian, Armstrong 2001, 2002; Hurtig, San Sebastian 2002). However, NSB and state monitoring to date has indicated that the subsistence food supply in the North Slope region as a whole is quite safe, and have concluded that the "benefits of a traditional food diet far outweigh the relative risks posed by consumption of small amounts of contaminants in traditional foods" (Alaska Native Health Board, 1999).

An accurate determination of specific HAP quantities and potential impacts is not feasible at this stage, given that particular site-specific development activities and pollution controls are not yet able to be predicted. Furthermore, there are few direct data addressing water or air concentrations of many contaminants in the region, nor are there data regarding levels of these contaminants in the human population. HAP are a source of great concern for North Slope residents, who feel that their exposure to contaminants is likely to be significantly greater than the general population because of their extraordinarily high rates of consumption of fish and game which feed in the region.

Thus, although data support the conclusion that the overall benefits of maintaining an active subsistence lifestyle, culture, and diet outweigh the unproven risks posed by North Slope

contaminants, data are insufficient to allow accurate modeling of the public health risks under this alternative. The level of predicted development activity under Alternative C, and the extent of reliance on resources in the area, however, suggest that there is justification for concern, investigation, monitoring, and efforts to minimize potential routes of exposure.

7. Infectious Diseases
As outlined in **section 3.4.10**, the prevalence of pulmonary disease is high; rates of HIV and syphilis are substantially lower in the North Slope than in the Alaskan and U.S. general population (Alaska Department of Public Health 2002 and 2005); Chlamydia rates are much higher in Alaska Natives than non-Natives in Alaska – there are no north Slope-specific data available at this time (Alaska Department of Public Health 2006). In our discussions with health care providers in the region, many commented that the North Slope community appears particularly vulnerable to respiratory infections. This observation has been made in other coastal Alaska Native populations as well (Singleton, Bruden et al. 2006).

Under Alternative C, there would be a greater potential for transmission of infectious diseases than under the other alternatives, owing to a greater projected level of activity in the region, including greater influx of workers from outside the region (refer to **section 4.5.18**). Transmission of respiratory infectious would be of greatest concern to vulnerable members of the community, including people with chronic illnesses and elders. Under Alternative C, an influx of personnel from outside of Alaska – where HIV and syphilis rates are generally substantially higher – could expose villages to a significant risk of increased incidence of these diseases. The NSB health department has tried in the past to address this problem though sending boxes of condoms to oil camps near villages, but existing resources in the NSB have not allowed a more coordinated public health effort to study or monitor transmission rates, nor to develop a more detailed public health approach to prevention. Diarrheal illnesses, common in groups of workers living and working in small enclosed facilities such as oil camps, could also pose a threat if infection spread to the community. Permanent roads linking the planning area with the road system could be allowed under Alternative C. Although not anticipated, if constructed, permanent roads could lead to increased travel to and from the planning area, and thus serve as another potential source of exposure to infectious diseases.

8. Social Determinants of Health
Impacts on the social determinants of health – both adverse and beneficial – would be greatest under Alternative C. Development involving the entire planning area would pose the greatest risk of rapid cultural change secondary to the large flux of workers through the region; restrictions in subsistence leading to a breakdown in sharing networks; increases in income disparity; and environmental degradation. Feelings of frustration, loss, disempowerment, and anger over the industrialization of a region of special and unique importance to Inupiat culture would likely be prevalent. Referring to Table 4.3-D, on the social determinants of health, these issues would impact social determinants including the social gradient, stress, social capital, and culture, income inequality, and environmental quality, all of which have well-documented public health implications.

There would be substantial benefits as well. Increases in employment and income would tend to benefit community well-being, particularly if local communities are able to work out adequate provisions for subsistence leave; income would also facilitate subsistence. As stated previously, the funding for infrastructure, public safety, and public health, as well as employment in the NSB comes almost entirely from oil and gas development, and this alternative would offer greater revenue to continue these programs.

Thus it is possible to identify both positive and adverse impacts to the social determinants of health from Alternative C. Given the central importance of subsistence to community well-being, however, if subsistence livelihoods are impacted such that communities are forced to substantially reduce their reliance on subsistence, it is likely that there would be an overall adverse impact on communities via effects on the social determinants of health.

Effects of Abandonment and Rehabilitation

The North Slope economy and citizens have become heavily dependent on revenue from oil and gas development. With the highest chance of both increases in employment and community income and restrictions in subsistence, Alternative C could lead to a significant shift away from subsistence diet and lifestyle. The relative economic depression and job loss which could follow the conclusion of rehabilitation work in this Alternative would be associated with a larger overall shift than the other alternatives, and could therefore be associated with the highest potential for social pathology. It is possible that subsistence resources could become more readily accessible after a period of adjustment. If this occurred, it would help offset the effect of decreasing capital available for purchase and repair of hunting equipment and fuel purchase. Another concern would come from the potential leakage of contaminants from wells and dumpsites: residents have expressed concern that if the area is less stringently monitored after development ceases, contamination of rivers, lakes, and estuarine habitats could ensue and would be missed, with substantial implications for human health. An example of this problem comes from prior development in Umiat. Although BLM is plugging wells at Umiat and the Corps of Engineers has ongoing projects to clean up other sources of contamination at Umiat, contamination has existed at several sites there for many years and has been a source of ongoing concern for residents of the region (Bessie O'Rourke, NSB attorney, personal communication by email, 2007). Overall, it is not at all clear whether people will be able to resume their pre-development way of life, whether subsistence resources will have become depleted, contaminated, or displaced, or how people will continue to support a lifestyle which depends heavily on modern technology. Viewed from the perspective of the social determinants of health, this period will have substantial implications for health given the large-scale economic and employment transition anticipated.

Effects of Oil Spills

Oil spills can affect human health in a number of ways. Direct contamination can produce toxicological effects; rashes and respiratory symptoms have been documented after acute exposure (Lyons, Temple et al. 1999). Longer-term effects from contamination of subsistence resources by organic compounds such as polycyclic aromatic hydrocarbons could lead to chronic exposure-related illnesses such as cancer, birth defects, miscarriages, and endocrine disruption (AMAP 2002; San Sebastian, Armstrong et al. 2001, 2002). Social and psychological effects of large oil spills are also a significant source of morbidity. Residents in the vicinity of an oil spill have been shown to have higher rates of anxiety disorder and post-traumatic stress disorder (Palinkas, Petterson et al 1993; Lyons, Temple et al 1993). A large oil spill could result in a significant decrease in subsistence activity, as was seen after the Exxon Valdez oil spill. In turn, this would to marked changes in social organization, decreased social capital, decreased consumption of subsistence foods, and an attendant increased risk of social pathology, injury, and diabetes and metabolic disorders (re. social capital and EVOS: Ritchie and Gill 2004). The magnitude of these problems would depend largely on the extent of the spill, and the degree to which it impacted local subsistence resources. Under Alternative C, the risk of a large spill is estimated to be greater than under the other alternatives, raising the chance that some of these health problems could occur.

4.5.19.3 Effectiveness of Stipulations and Required Operating Procedures

The performance-based lease stipulations and ROPs developed for Alternative B would also apply to Alternative C (see **section 4.4.19.3** for an assessment of the effectiveness of the ROPs and lease stipulations). Under Alternative C, no areas would be withdrawn from year-round occupation except the buffer zones around deepwater lakes, with the same exception clauses as the other alternatives. Under this alternative, oil exploration and development could occur over a wider area, in more sensitive areas and habitats, and in lakes.

When considering the effectiveness of stipulations in mitigating public health effects, it must be recognized that because the Inupiat people continue to value this land deeply as a foundation of well-being and culture, any measure which contributes to minimizing the environmental impacts of development in the region can be seen as contributing positively toward overall health and well-being. On the other hand, North Slope residents and the North Slope Borough have expressed a great deal of concern that the new "adaptive management" strategy adopted in Alternatives B, C, and D may result in considerable weakening of protections for the area, and well as creating a situation of perpetual flux and uncertainty as the increased flexibility offered under the new system creates the opportunity for important protections to be overridden by economic and industry concerns. Hence, from this perspective, the entire adaptive management program may be seen as a significant stressor, with the attendant health problems as described in **section 4.5.19.2** on social determinants of health above.

Overall, the extent to which the Stipulations and Required Operating Procedures for Alternative C mitigate human health concerns will be proportional first to the degree to which the flexibility they provide is enforced to protect the local environment; to the degree to which they prevent impacts to subsistence resource populations, displacement of subsistence resources, and displacement of hunters and their families; on the efficacy of controls on environmental contamination, and on measures taken to reassure the community regarding their concerns about environmental contamination; and on the degree to which they prevent the adverse consequences of sociocultural change and support the positive aspects associated with employment and economic opportunity. Overall, however, in the face of expanding development, particularly with the development of important subsistence areas, it is likely that there would be substantial unmitigated impacts to health and the social determinants of health.

4.5.19.4 Conclusion

Under Alternative C, the possibility of public health impacts would be greater than under the other alternatives. These impacts would occur primarily through restriction in subsistence; influx of large numbers of outside workers; new access routes to the community; sociocultural and economic change; altered employment; and contaminants. Diabetes, hypertension, and related metabolic disorders would be expected to increase as subsistence is curtailed or as sociocultural changes lead to alterations in dietary patterns. Given that Alternative C involves the potential of development throughout the entire region, the risk of dietary change leading to metabolic disorders and of food insecurity are both substantially higher. Although at present no evidence exists to conclusively link rates of contaminant-based health problems, such as cancer, lung disease, endocrine disruption, and neurodevelopmental delay to local oil development, the risk of contaminant-based health problems would also be highest under Alternative C, owing to the increased total emissions projected, as well as the distribution of emissions sources throughout the subsistence range. Mitigation includes stipulations which regulate discharges, and permits to comply with ADEC and CAA provisions. Social pathology could result from the

economic changes anticipated; from increasing access to drugs and alcohol; and from stress and maladaptive coping given the impacts to wider regions of important traditional use areas. While measures such as Stipulation I-1, which mandates a cultural orientation program, it would not be expected to entirely offset the large-scale socio-economic impacts discussed in the preceding sociocultural and public health sections.

4.5.19.5 Potential New Mitigation Measures

The same potential mitigation measures are proposed for this alternative as for Alternative B, as discussed in **section 4.4.19.5**. Overall, the benefits of these new measures would be similar to the other alternatives in terms of the range of public health effects they address. But because Alternative C would be associated with the greatest potential impacts to public health, these new potential mitigation measures would have the greatest potential benefits under this Alternative. Measures 1 and 3 would establish a framework to ensure that potential public health effects are adequately evaluated during the planning process, and establish a mechanism for ongoing monitoring of public health effects. Owing to the greater extent of development predicted under Alternative C, these measures would provide similar but greater overall benefits than those described under Alternative A. Because development would be allowed over a greater region and within particularly important subsistence regions, however, there may also be greater residual overall health effects. Measure 2, Subsistence Harvest monitoring, would provide relatively greater benefit than that described under Alternative A, because of the greater potential for impacts to subsistence under Alternative C, but again with a potential for greater residual effects. Measure 4, Control of Contaminant-Related Health Risk, would provide protection for contaminant-related health problems as well as helping to reassure communities of the continued safety of subsistence resources. Because, under Alternative C, development would be allowed throughout the planning area, this measure would provide relatively greater benefit than under Alternative A or B. Certainly though, given the greater extent of development, there could also be greater residual impacts, including both contaminant-related health problems, and problems related to decreased consumption of subsistence resources (including metabolic disorders and food insecurity, and social pathology and injury rates). Measures 6 and 7, through adding health concerns into required orientation programs for industry employees, would have equivalent benefits under Alternative C to those described under Alternative A or B. Owing to the slightly increased risk of oil spills under Alternative C, measure 8 would offer proportionally greater protection. These mitigation measures would have benefits to subsistence activities and surface resources similar to those identified for Alternative A. Like their benefits to public health, these measures would like provide greater benefit for subsistence, caribou, and waterfowl than the same measures for Alternative A, because Alternative B makes available for leasing and development areas of considerable value for subsistence, caribou, and waterfowl. And as described for public health, there could also be greater residual impacts to these resources than under Alternative A.

Potential Effects on Oil and Gas Development

The expense of the above potential mitigation measures varies widely, from insignificant to potentially millions of dollars. To the extent that the potential mitigation measures would add expense to oil and gas activities, they could discourage leasing, exploration, and development of oil and gas.

4.6 ALTERNATIVE D

4.6.1 Air Quality

4.6.1.1 Activities Not Associated With Oil and Gas Exploration and Development

Air quality impacts associated with these activities are the same as those associated with Alternative A, discussed in **section 4.3.1.1.**

4.6.1.2 Oil and Gas Exploration and Development Activities

The Air Pollutant Emission Sources, Effects of Air Pollution, and Native Views on Air Emissions are the same as those associated with Alternative A, discussed in **section 4.3.1.2.**

Air Pollutant Emissions

Air pollutant emission estimates for Alternative D were based on the following information sources:

1) Helicopter emissions were based on the Federal Aviation Administration's Emissions and Dispersion Modeling System (EDMS version 4.1) for a Bell 206 (Edwards, 2007);
2) Emission estimates developed for the Alpine Satellite Development Plan (USDOI BLM, 2004c) for satellite well pad/access road construction, fixed wing aircraft flights, drilling rigs, and specific production equipment (satellite heaters, field generator, and a CPF turbine); and
3) Actual 2006 air pollutant emissions from the ConocoPhillips Alpine Production Facility (Poteet, 2007).

These emission factors were adjusted for the following assumed activities under Alternative D:

1) Helicopters: 5,000 one-hour flights per year;
2) Exploration/Delineation: up to 144 fixed wing flights per year, 110 exploration wells and 83 delineation wells, 7 drill rigs;
3) Construction: 3,401 fixed wing flights per year, 2 drill rigs, 4,378 acres of land disturbance; and
4) Production: 672 fixed wing flights per year, 32 satellite well pads, 6 Central Production Facilities, and 76 MMbbl peak annual oil production.

Based on these emission factors and anticipated activity, the maximum annual emissions (in tons per year) by activity phase are presented in Table 4.6-A.

Development and production activities can also produce fugitive dust emissions (primarily as PM_{10}). Fugitive dust occurs primarily during the summer months due to driving on unpaved roads. Vehicles can also track out fine material from gravel mining operations in the winter and summer months. Potential control measures include limiting vehicle speeds, and treating problematic road sections with surfactants or water.

Well closure, abandonment and rehabilitation activities would emit air pollutants similarly to those during development (construction), since similar vehicles and other emission sources would be used. Because closure activity would not occur at a single location for any substantial

length of time, the impact of air emissions at any single location would be minor and short term. Impacts could be minimized by leaving gravel on-site, limiting the amount of transport. Once reclamation is complete, production facilities would no longer impact North Slope air quality.

In comparison, a site-specific air quality impact analysis was conducted for the off-shore Liberty Project (USDOI MMS, 2002), which would be somewhat smaller than a typical field that could be developed in the planning area, which demonstrated ambient air quality levels would be close to, but within applicable PSD Class II increments. The combined facility concentrations plus background were predicted to remain well within the ambient air-quality standards (between 2 and 30% of the standards). Because Alternative D facilities would have similar air emissions as those predicted for the Liberty Project, it is likely potential satellite well pads and central production facilities would have similar air quality impacts. However, the accuracy of determinations of specific air pollutant emissions and potential impacts is necessarily limited at this stage, given that particular site-specific development activities are not yet able to be predicted.

Since CO_2 has not been regulated as an air pollutant, potential CO_2 emissions were not quantified for Alternative D. However, assuming an average 98% combustion efficiency, the CO emissions reported in Table 4.6-A may be multiplied by 80 to estimate equivalent CO_2 emissions (a maximum of 24 x 10^4 tons per year.) However, when compared to estimated worldwide emissions of CO_2 (nearly 28 x 10^9 tons per year), Alternative D would contribute minuscule amounts of CO_2 emissions to global levels.

4.6.1.3 Effectiveness of Stipulations and Required Operating Procedures

No air quality lease stipulations or ROPs were included for Alternative D. Potential air quality impacts from site-specific development activities would be limited based on air quality permits issued by the ADEC and EPA, including applicable control technologies.

4.6.1.4 Conclusion

Air quality impacts from Alternative D are likely to remain below applicable ambient air quality standards and increments, therefore no significant impact to air quality is expected. Air pollutant emissions associated with Alternative D are approximately 23 to 26% greater than Alternative A (No Action), more than Alternative B, but less than Alternative C. Each new exploration or development activity, or production area, would result in an additional air pollutant emissions. The accuracy of determinations of specific air pollutant emissions and potential impacts is necessarily limited at this stage, given that particular site-specific development activities are not yet able to be predicted. As exploration and development activities cease, or production sites are shut-in, there would be a corresponding decrease in air emissions.

Table 4.6-A. Alternative D Air Pollutant Emissions from Surface Activities (tons per year)

Activity Phase	Carbon Monoxide	Nitrogen Oxides	Particulate Matter [1]	Sulfur Dioxide	Volatile Organic Compounds
Helicopters	10	1	1	<1	<1
Exploration/ Delineation	41	187	9	21	<1
Construction	100	377	26	30	32
Production	2,901	15,165	350	469	333
Total	3,054	15,730	386	520	366

Source: Archer, 2007

[1] Combustion sources primarily emit $PM_{2.5}$ while land disturbance primarily emits PM_{10}.

4.6.2 Paleontological Resources

4.6.2.1 Activities Not Associated With Oil and Gas Exploration and Development

Under Alternative D, the types of non-oil and gas activities would be the same as those described for Alternative A; however, there would be likely be an increase in the level of aircraft and survey activity associated with environmental studies and monitoring. Despite increased activity, the impact to paleontological resources, which are deeply buried, would still be minor.

4.6.2.2 Oil and Gas Exploration and Development Activities

Under Alternative D the level of seismic activity is expected to increase beyond that of Alternative A because an additional 389,000 acres would be available for leasing, and these additional acres would be in an area with high oil and gas potential. While the types of impacts to paleontological resources would remain the same, the increased level of seismic activity would increase the potential for impacts to occur. Any impacts associated with the increased seismic activity are expected to be minor.

Significant paleontological resources (primarily vertebrate fossils) are not ubiquitous in the planning area. These resources are exposed primarily through erosion (stream cuts, bluff faces, etc.), elsewhere they are usually deeply buried. As a result, the location of exposed material can be to some degree predicted and therefore avoided while the remainder is protected by its depth of burial.

Effects of Disturbances

Under Alternative D the level of activity in the planning area would increase. However, because most of the activity would occur during the winter months, the potential for impacts to paleontological resources is extremely minor. The likelihood of impacting surface paleontological material also is minor due to their isolated and rare occurrence.

The drilling of exploration wells and delineation wells typically would occur during winter. It is expected that no more than seven wells would be drilled at any one time. Drill pads, camp pads, roads, and airstrips made of ice and snow would be used, but permanent pads, roads, or airstrips could also be constructed; therefore, ground disturbance could occur and buried paleontological material could be impacted. The other substantial subsurface disturbance that would occur as a result of the actual drilling would be the making of the drill hole itself. If scientifically important paleontological material were present at the site of the borehole, these resources could be impacted by the drilling practice. However, the likelihood of such an occurrence is minor.

Surface disturbance from development could impact as much as 4,378 acres, but there would be limited subsurface impacts associated with these activities. The primary impact to paleontological resources would result from the excavation of material for construction of the permanent facilities. Extraction of the terrestrial materials could impact paleontological resources. Pleistocene vertebrate fossils are commonly recovered during gravel-mining operations on the North Slope. It is anticipated that a pipeline would not have associated all-weather roads or pads and would be constructed during the winter months from ice roads and/or pads. Therefore, the only substantial impact resulting from pipeline construction would be associated with the placement of VSMs. Depending on the depth at which the VSMs were set it is possible, though highly unlikely, that paleontological resources would be impacted. Overall, ground disturbance from development would have a minor impact on paleontological resources.

It is unlikely that cultural resources would be impacted by abandonment activities

It is unlikely that paleontological resources would be impacted by abandonment activities as any paleontological resources within the effected area would have been noted through survey prior to or during the initiation of activities.

Effects of Spills

Under Alternative D the effects of spills to paleontological resources would be the same as discussed under Alternative A. If present, surface paleontological material could be impacted; however since the occurrence of paleontological remains is rare, the probability of an impact is minor.

Commercial Gas Development

The types of impacts on paleontological resources that natural gas development and production would cause would be the same as those caused by oil development described above, except that there would be no crude-oil spills and if a gas pipeline is buried—the likely method—there would be additional acreage disturbed with increased potential for disturbance or destruction of paleontological resources. As with Alternatives A and B, it is anticipated that burying the pipeline would result in digging up approximately 162 miles of four feet wide and five feet deep trench (approximately 80 acres) and potential surface disturbance of 210 acres in areas adjacent

to the trench from potential disturbance from machinery or placement of backfill. The risk to paleontological resources would be reduced dramatically if gas pipelines are put on VSMs. Additional disturbance would occur from disturbance associated with building a 10- to 20-acre compressor pad.

4.6.2.3 Effectiveness of Stipulations and Required Operating Procedures

As discussed under Alternative B, the ROPs and lease stipulations under Alternative D would be highly effective in protecting known and previously unknown paleontological resources and preserving their research potential and, ensuring that impacts to paleontological resources would be minor.

4.6.2.4 Conclusion

The types of impacts to paleontological resources from management activities other than oil and gas exploration and development would be similar in nature to what was described for Alternative A. The potential impacts to paleontological resources from oil and gas exploration and development could increase about 50% from levels associated with Alternative A, based on area of surface disturbance. Impacts could be greater if exploration and development occurred in an area with abundant paleontological resources. However, the ROPs and lease stipulations proposed to protect paleontological resources under this alternative would be highly effective.

4.6.3 Soil Resources

4.6.3.1 Activities Not Associated With Oil and Gas Exploration and Development

Various types of activities not related to oil and gas leasing and development, including private or commercial air traffic, summer research camps, use of OHVs, recreational camps, paleontological and archaeological excavations, and overland moves could affect soil resources in the planning area under Alternative D.

Under Alternative D, impacts associated with non-oil and gas activities would be similar to those described under Alternative A for all alternatives. These activities could occur throughout the planning area and would be little affected by the increased availability of land for oil and gas leasing.

4.6.3.2 Oil and Gas Exploration and Development Activities

The following analysis is based on **section 4.2.1.2, *Oil and Gas Exploration and Development Activities***. See that section for a discussion of estimates and assumptions for development as well as a description of how estimated areas of disturbance were calculated for each alternative.

During oil and gas exploration and development, various activities could cause impacts to soil resources in the planning area. These activities include seismic activities; construction and use of gravel pads, gravel roads, gravel airstrips, and pipelines; excavation of material sites; construction of ice roads and ice pads; and summer tundra travel. Impacts could also occur from oil spills and from removal of gravel pads and gravel roads during rehabilitation. These activities would impact soil productivity and could alter the moisture regime of tundra near the

structure by changing natural drainage patterns and areas where snow accumulates. Types of impacts to soils from oil and gas activities in Alternative D would be similar to those described for Alternative A. Differences in the magnitude and area of impacts for Alternative D are described below.

Effects of Disturbances

Seismic Surveys

Effects to soils from seismic surveys would be the same as for Alternative A. Under all of the alternatives, it is projected that three 2-D and two 3-D surveys would be done to fill in gaps in existing surveys.

Exploration

Under Alternative D, types of impacts to soil from activities associated with oil and gas exploration would be similar to those described for Alternative A. However, the area impacted would be somewhat greater than in Alternatives A and B and slightly less than Alternative C.

The drilling of exploration and delineation wells would result in impacts to soil from both multi- and single-year ice pads. The area of soil directly impacted by a typical ice pad (500 feet by 500 feet) would be approximately 6 acres. Under Alternative D, it is assumed 110 exploration wells and 83 delineation wells, or a total of 193 wells, would be drilled from ice pads in the planning area. Impacts to soils would occur on approximately 1,200 acres (193 ice pads x 6 acres per ice pad) over a period of about 25 years.

In addition, up to 50 miles of ice road would be constructed annually temporarily impacting approximately 212 acres per year. For Alternative D, it is estimated that a total of about 6,200 miles of ice road would be constructed during the life of the plan for exploration and development impacting approximately 19,000 acres (Table 4.2-G). In addition, approximately 30 miles of ice runway would be constructed impacting approximately 330 acres.

The construction of well cellars during exploration requires digging a hole that would impact approximately 16 square feet (0.0004 acres) of ground for each well. Total area disturbed by digging well cellars under Alternative D would be approximately 0.07 acres (193 wells x 0.0004 acres per well). Thermokarst associated with the disruption of the thermal regime in the surrounding soil could occur around the well cellars and cause long-term disturbance to these small areas.

Placement of Gravel Fill

Types of impacts to soils from placement of gravel fill would be similar to those in Alternative A. Construction of CPFs and associated satellite pads, roads, and airstrips would result in the loss of soil productivity in the areas of gravel placement. Under this alternative, 6 fields would be developed, resulting in a total of approximately 3,700 acres of soil productivity lost by gravel placement.

Construction of gravel pads, roads, staging areas, and airstrips could alter the moisture regime of tundra near the structure by changing natural drainage patterns and areas where snow accumulates. Snowdrifts caused by gravel structures would increase the wintertime soil surface temperature and increase thaw depth in soils near the structures. These impacts would be

exacerbated by dust deposition and by the formation of impoundments. These factors could combine to warm the soil, deepen thaw, and cause thermokarst adjacent to roads and other gravel structures (NRC 2003). In flat, thaw-lake plains on the North Slope, gravel construction can be anticipated to result in upslope water impoundment and thermokarst erosion equivalent to the area directly covered by gravel (Walker et. al. 1987). In this analysis, approximately 3,700 acres could be covered by gravel under Alternative D. Therefore, the total area of soils impacted by gravel fill under Alternative D is estimated at approximately 7,400 (2 x 3,700) acres. This is greater than Alternatives A and B and somewhat less than Alternative C.

Material Sites

In this analysis, gravel required for Alternative D would be greater than that required for Alternatives A and B and less than Alternative C. Gravel required for development in the planning area could be mined from existing sites east of the planning area or could be extracted from new sites developed within the planning area. Investigations to identify gravel sources in the planning area have not been conducted, but presumably would be initiated if discoveries of recoverable oil or gas were made. It is possible that 14 gravel mine sites would be necessary, resulting in a total of 700 acres impacted, depending on the actual number of sites required. Types of impacts from gravel excavation would be similar to Alternative A and the other alternatives. Excavation of the gravel mine and stockpiling of overburden would remove soil and impact soil productivity at these sites.

Pipelines

Under Alternative D, types of impacts to soil from pipelines would be similar to those described in Alternative A. Given the potential number of fields developed in this analysis, impacts from pipeline construction would be greater than those described for Alternatives A and B but less than those for Alternative C. Pipelines on the North Slope are typically built on VSMs with a diameter of 12 inches and a spacing of 150 VSMs/mile. Under Alternative D, approximately 482 miles of pipeline would be required resulting in short term disturbance to soils of approximately 1,500 acres and a long term impact at VSM sites to a total of approximately two acres.

The extent of impacts associated with buried pipeline could be similar to alternatives B and C. Melting of ice in the soils would result, and the filled area, normally mounded immediately after placement of fill, would level over time as melt water migrated to lower areas. Because pipeline burial under tundra has been the exception on the North Slope rather than the norm, it is expected that this activity would disturb only a small amount of area in the planning area.

Effects of Oil and Gas Development on Permafrost

Types of impacts to permafrost from oil and gas development would be the same as those described in Alternative A. Under alternative D, more surface disturbance is expected from oil and gas activities as compared to Alternatives A and B but less than Alternative C (Table 4.2-G). Therefore, the potential area of permafrost impacted would be expected to be greater than in Alternatives A and B and less than in Alternative C.

Abandonment and Rehabilitation

Types of impacts from abandonment and rehabilitation would be the same as those described in Alternative A. Under alternative D, it is expected that more structures would be constructed for oil and gas activities as compared to Alternatives A and B but less than Alternative C (Table

4.2-G). Therefore, the amount of rehabilitation required, and impacts to soils from abandonment and rehabilitation, would be greater than in Alternatives A and B but less than Alternative C.

Effects of Spills

Under Alternative D, types of impacts to soils from spills would be similar to those described for Alternative A. However, the potential for a greater amount of leasing, development, and production of oil could result in a larger number of small spills of crude and refined oil in the planning area compared with Alternatives A and B. There would also be a greater chance of a large oil spill occurring than with Alternatives A and B; nonetheless, a large spill would likely still be a very rare event (see **section 4.2.2, *Oil Spills***).

Summer Tundra Travel

Under Alternatives B, C, and D some summer tundra travel would be permitted under specific circumstances. Although travel off of gravel pads is easiest in winter and generally environmentally preferable at that time, some vehicle travel off of pads does occur in North Slope oil fields during the summer to accomplish specific tasks. The State of Alaska has approved some low-ground-pressure vehicles for summer tundra travel after July 15. Similar summer tundra travel may be anticipated to be part of oil production in Northeast NPR-A.

Summer vehicle tundra travel is commonly associated with spill prevention and preparedness measures required in spill prevention plans. Each summer season, low-ground-pressure vehicles might be used to transport and place booms across streams downstream from pipelines. These booms are left in place through the summer to capture any oil that might spill from a pipeline and then would be retrieved, again probably using low-ground-pressure vehicles, before freeze-up. Pipeline inspections may also entail summer vehicle travel on the tundra. Finally, periodically spill response training may occur along and downstream from pipelines in summer.

As a rule, summer tundra travel would not be permitted under Alternative A. Therefore, given the potentially greater number of fields developed and allowance of summer tundra travel under certain circumstances, impacts from summer tundra travel under Alternative D could be greater than in Alternatives A and B and less than Alternative C. Short-term, minor impacts to soils are expected from limited summer tundra travel using low ground pressure vehicles. However, ROP L-1 is designed to regulate and monitor summer travel and minimize impacts to soils and vegetation. Summer travel would only be permitted on a case-by-case basis if the applicant can demonstrate that the proposed use would have no more than minimal impacts to soils and vegetation.

Commercial Gas Development

Under Alternative D, the types of impacts on soils that natural gas development and production would cause would be the same as those described for the other alternatives. If a gas pipeline is buried, there would be additional acreage of soils disrupted with reduced soil productivity. The estimated 162-mile-long gas pipeline would impact about 80 acres of soils directly through excavation of a 4-foot-wide trench and, potentially, 210 acres through compaction, thermokarst, and other indirect effects. In addition, ice roads that may be associated with placement of the gas pipeline would have localized, short-term impacts on soils, which would usually be limited to compression of the tundra under the ice roads and damage to the tops of tussocks in dryer soils.

Soils thus disturbed in the ice-rich northern part of the planning area are more likely to experience thermal degradation and subsidence as a result. In this case, the soils would not be lost completely, but soil horizons as well as the thermal regime would be altered. Melting of ice in the soils would result and the filled area, normally mounded immediately after fill, would level over time as melt water migrates. Ponding, and potentially soil erosion, could occur if the trench surface subsides below the grade of the surrounding terrain over time. These impacts would be dramatically reduced if gas pipelines were put on VSMs.

4.6.3.3 Effectiveness of Stipulations and Required Operating Procedures

To protect soils in the planning area, the approval of most proposals for summer operations are limited. Because of the fragile nature of thawed tundra during the summer, permit sites are restricted to durable areas such as gravel bars, beaches, or existing gravel pads. Vehicles allowed for use in overland moves would exert low ground pressure and be permitted to travel only over snow-covered ground frozen to a sufficient depth to minimize soil and vegetation impacts. Even so, development in the planning area would result in impacts to soils. However, several Lease Stipulations and ROPs for Alternative D should be effective in limiting these impacts. Lease stipulations and ROPs developed to protect soil under Alternative D would provide similar protection to those developed for Alternatives B and C. Lease Stipulation K-11 applies only to Alternative D. This stipulation would limit surface disturbance to 300 acres each in tracts A-G north of Teshekpuk Lake (not including pipelines). This stipulation should be effective in minimizing the amount of soil disturbance in these tracts north of Teshekpuk Lake. Existing gravel pads within the tracts would not count against the 300 acre limit for each tract.

Similar to the other alternatives, many of the lease stipulations and ROPs developed under Alternative D would directly or indirectly limit potential impacts to soils in the planning area. These ROPs and lease stipulations would provide similar protection to those provided for Alternative A.

4.6.3.4 Conclusion

Under Alternative D, the amount of soil area impacted from oil and gas exploration and development would potentially exceed those of Alternatives A and B as additional high-potential oil and gas areas would be available for leasing. However, this analysis assumes both short and long term disturbance to soils would be less than in Alternative C. See Table 4.2-G for a comparison of estimated total surface area disturbed by alternative.

Numerous technological advancements have been made during the decades of operations on the North Slope that have allowed current development activities to proceed with less environmental impact than previous operations (NRC 2003). However, some short-term disturbance and permanent long-term impacts to soils are inevitable. Impacts to soil from management actions under Alternative D would involve short-term disturbance over fairly large areas and long-term disturbance of relatively small areas. Impacts in this alternative cover more of the planning area than Alternatives A and B but less than Alternative C (see Table 4.2-G). All areas of soil disturbance would be small as a percentage of the entire planning area (see below). The duration of these impacts could range from one year or less for minor disturbance of soil and vegetation to decades if the soil was destroyed or permafrost thawing was extensive.

Under Alternative D, impacts to soils from activities other than oil and gas development would be similar to the other alternatives and would include minor impacts from aircraft landings, archaeological or paleontological excavations, camps, and overland moves. Recovery would vary from one year or less for minor disturbance of soil and vegetation to decades in those areas where soil was excavated or permafrost thawing was extensive.

Impacts from seismic activities would be the same for all alternatives. Short-term impacts could occur on approximately 8,100 acres (0.18 % of the planning area) of soil from 2-D seismic surveys and 100,000 acres (2.2 % of the planning area) of soil from 3-D surveys during a 25-year period (Table 4.2-F).

Approximately 1,500 acres could be impacted short-term by pipeline construction. Short-term impacts would also occur from temporary ice roads, ice pads, and ice runways. For Alternative D, it is estimated that a total of 6,200 miles of ice road would be constructed during the life of the plan for exploration and development impacting approximately 19,000 acres (Table 4.2-G). In addition, approximately 1,200 acres could be impacted by ice pads for exploration and delineation wells and 30 miles of ice runway would be constructed impacting approximately 330 acres. In total, potential short-term impacts to soils under Alternative D from exploration (excluding seismic activities) and development would be approximately 22,000 acres or 0.48% of the planning area. This is greater than Alternative A, slightly greater than Alternative B, and less than Alternative C.

Oil and gas development and operation would affect soils by compacting and damaging soils under gravel pads, gravel roads, and gravel airstrips; and by excavating material sites and constructing VSMs. These impacts would be long-term. Long-term impacts would occur on an estimated 7,400 acres of soil from field and staging area development, and 700 acres from gravel extraction activities. Therefore, these activities could result in long-term impacts to approximately 8,100 (7,400 + 700) acres or 0.18% of the planning area. The placement of pipelines underground could disturb an additional 1.5 acres per pipeline mile. However, because pipeline burial under tundra has been the exception on the North Slope rather than the norm, it is expected that this activity would disturb only a small amount of area in the planning area. In total, long-term impacts to soil resources could be greater than under Alternatives A and B and less than under Alternative C.

Impacts associated with oil spills, the majority of which would be cleaned up immediately, could aversely affect soil resources for a few years to several decades depending on the quantity, location, and season of the spill. Based on oil and gas potential and the estimated number of large and small spills, impacts from oil spills could be greater under Alternative D than under Alternatives A and B but less than that for Alternative C (see **section 4.2.2, *Oil Spills***).

Under Alternatives B, C, and D some summer tundra travel would be permitted under specific circumstances. Short-term, minor impacts are expected from limited summer tundra travel using low ground pressure vehicles. However, ROP L-1 is designed to regulate and monitor summer travel and minimize impacts to soils and vegetation. Summer travel would only be permitted on a case-by-case basis if the applicant can demonstrate that the proposed use would have no more than minimal impacts to soils and vegetation.

Impacts to soil resources from non-oil and gas activities, and from oil and gas activities, would likely be additive in most cases, except in those areas where the two types of activities overlapped. In these areas the total actual impact could be less than the sum of both impacts because some of the activity would occur on areas already impacted. Impacts to soil resources

from exploration and development activities would also be additive, except where development activities occurred in areas previously disturbed during exploration. In areas where two or more activities occurred, overall impacts would reflect those impacts associated with the first activity and any new impacts associated with later activities.

Although all soil map units identified on Map 3-5 could be impacted during oil and gas exploration and development, soils associated with map units IQ6 and IQ21 (see **section 3.2.7, *Soil Resources*** and Map 3-5) would likely be most affected since they are located in the area having high oil potential.

Lease stipulations and ROPs have been identified to protect soil resources. Lease stipulations and ROPs developed for Alternative D would provide protection similar to that offered by lease stipulations developed for Alternative A and are the same as those developed for Alternatives B and C. However, Lease Stipulation K-11 applies only to Alternative D. This stipulation would limit surface disturbance to 300 acres each in tracts A-G north of Teshekpuk Lake (not including pipelines). This stipulation should be effective in minimizing the amount of soil disturbance in these tracts north of Teshekpuk Lake. Existing gravel pads within the tracts would not count against the 300 acre limit for each tract.

4.6.4 Water Resources

4.6.4-a Surface Water and Groundwater Resources

Under the Alternative D, approximately 95% (or 4.39 million acres) of the acreage in the planning area would be open for leasing. Because this is substantially more acreage than under Alternative A, more surface water could be impacted by oil and gas activities under this alternative. However, under the Alternative D, performance-based lease stipulations and ROPs very similar to those developed for alternatives B and C would be used to mitigate the impacts of energy exploration and development on surface resources. In addition, three new lease stipulations are proposed for Alternative D, and additions, deletions, and edits have been made to the proposed performance-based mitigations designed for alternatives B and C that would apply to Alternative D and would increase protection to surface resources throughout the planning area. Setbacks from rivers, streams, and fish-bearing lakes would be in the range of ½ to 3 miles. The main difference between this alternative and the Alternative A pertaining to water resources is that the Alternative D allows for drilling near Teshekpuk Lake and within the Teshekpuk Lake Special Area, whereas the Alternative A does not allow for drilling near the lake. This greatly increases the likelihood of exploration or development activities impacting water resources and quality in the lake. However, Teshekpuk Lake itself would be deferred from leasing.

4.6.4-a.1 Activities Not Associated With Oil and Gas Exploration and Development

Activities not related to oil and gas exploration and development that could occur in the planning area under Alternative D include aircraft use, watercraft use, collection and excavation for scientific research, hunting camps, recreational use of the area, and use of the area by local natives for subsistence. These activities would be expected to occur at the same frequency and intensity under all alternatives as described in Alternative A. All of these activities have the potential to impact water resources. However, all of these activities have also been ongoing for many years with minimal impact to water resources.

4.6.4-a.2 Oil and Gas Exploration and Development Activities

Under Alternative D, exploratory and developmental drilling would be allowed near Teshekpuk Lake, subject to the restrictions listed in Lease Stipulations K-4, and K-9 through K-11 (see **section 2.6.4.2, *Lease Stipulations that Apply to Biologically Sensitive Areas***). Although these lease stipulations and the other lease stipulations in K-3 are generally protective of the water quality in Teshekpuk Lake, drilling near the lake increases the risk for an oil spill that could affect this lake. However, lease stipulation K-3 requires a minimum of ¼ mile setback from the Lake for oil and gas facilities and this should reduce the likelihood of a spill reaching the Lake. Teshekpuk Lake itself would be deferred from leasing under this alternative.

Effects of Exploration and Development

Seismic activities and overland travel. Effects to water resources from seismic surveys would be the same as those described for Alternative A. Under all of the alternatives, it is projected that three 2-D and two 3-D surveys would be done to fill in gaps in existing surveys and amount to the same level of impacts.

Ice Road and Pad Construction. Types of impacts from ice road and pad construction would be the same as those described under Alternative A. Under Alternative D the potential impacts of ice roads on water resources would be greater than Alternative A, similar to Alternative B, and less than Alternative C. For Alternative D, it is estimated that a total of 6,162 miles of ice road (18,672 acres), 193 exploration and delineation well ice pads (1,200 acres), and 30 ice airstrips (330 acres) would be constructed during the estimated exploration and development scenario resulting in a total of 20,202 acres of short-term surface disturbance . Impacts to the tundra under this alternative should be minimal and limited mainly to the spring when the ice roads and pads would melt and add somewhat saline water to the shallow tundra pools. This impact would likely be temporary in nature, since these ponds will be recharged by local snowmelt and runoff.

Ice Road/Pad Water Use. Types of impacts from ice road/pad water use would be the same as those described under Alternative A. Approximately 50 miles of ice road would be needed each year under all alternatives resulting in the use of approximately 75 million gallons (MG) of water per year (50 miles x 1.5 MG/mile). However, it is estimated that more water would be used over the life of the Plan than under Alternative A and B since more high oil and gas potential area would be open for exploration and development and ice roads, pads, and airstrips constructed.

Drilling & Camp Water Use. Types of impacts from drilling water use would be the same as those described under Alternative A. Under Alternative D, water withdrawal from lakes for drilling water would be governed by the same ROPs and lease stipulations as those for ice roads and pads. Therefore, it is expected that impacts to surface water resources would be minor because of lease stipulations governing the amount of drawdown allowed in the lakes, and which lakes could be used as water sources. Because more of the planning area would be open to leasing under Alternative D, more lakes could potentially be impacted by water withdrawal during the winter months than under Alternative A. Lease Stipulations K-1 (Rivers Area) and K-2 (Deep Water Lakes) would be protective of water resources in streams and fish-bearing lakes, but given the greater number of lakes, Alternative D could potentially have more impact on lakes, especially non-fish bearing lakes, than Alternative A.

Snow Compaction. Types of impacts from snow compaction would be the same as under Alternative A . Because a greater portion of the planning area would be open to oil and gas leasing under Alternative D, there could potentially be more impacts from snow compaction than under the Alternatives A and B, but less than Alternative C. Under all alternatives, snow compaction would be prohibited on fish-bearing lakes, except at ice road crossings. Therefore, this alternative would be protective of lakes and streams. No impacts to ice thickness on fish-bearing lakes are expected as a result of oil and gas exploration and development activities. However, lakes without fish could be subject to impacts due to snow compaction if this activity were authorized by the AO.

Drainage Disruption. Types of impacts from disruption of drainage patterns would be the same as those described under Alternative A. Under Alternative D, drainages would be protected by ROPs and lease stipulations. These ROPs and lease stipulations require setbacks from specified rivers, require bridges rather than culverts for crossing major rivers, and require that culverts used for small drainages have ample capacity to handle the flow of the drainage during spring breakup to avoid ice jams. Thus, this alternative would minimize impacts to drainages from construction of permanent and temporary facilities related to crossing the drainage. Overall, impacts to drainages should be minor under this alternative as a result of these lease stipulations.

However, because a greater portion of the planning area would be open to oil and gas leasing under Alternative D, there could potentially be more disruption of drainages than under the Alternative A and B, but less than Alternative C. However, if the lease stipulations and ROPs listed for this alternative are followed, this potential increase in impacts should be minor.

Additional lease stipulations for Alternative D would reduce the impact of gravel structures in some areas. The additional lease stipulations and changes would prohibit permanent oil and gas facilities except pipelines on approximately 240,000 acres north and east of Teshekpuk Lake. Finally, a new site-specific stipulation would establish a maximum limit of 300 acres of permanent surface disturbance from oil and gas activities within each of seven lease tracts identified north of Teshekpuk Lake. Theses seven lease tracts range in size from approximately 46,000 acres to 59,000 acres. These additional stipulations would help to minimize potential impacts to water resources.

Channel Erosion and Sedimentation. Types of impacts from channel erosion and sedimentation would be the same as those described under Alternative A. Lease stipulations and ROPs developed for Alternative D to mitigate for disturbances to drainages, streams, and rivers by exploration and production activities would be similar to those developed for Alternatives B and C. These lease stipulations and ROPs regulate bridges, culverts, winter crossings, removal of ice bridges, and any temporary facilities constructed near rivers. They also include setbacks for specified rivers. These ROPs and lease stipulations should mitigate impacts to stream channels. Because a greater portion of the planning area would be open to oil and gas leasing under Alternative D, there could potentially be more impacts from channel erosion and sedimentation than under the Alternative A and B, but less than Alternative C. Lease stipulations and ROPs developed for this alternative would minimize this potential increased impact to stream channels from erosion and sedimentation.

Gravel Removal. Types of impacts to water resources from gravel sites would be the same as those described under Alternative A. Under Alternative D, gravel mining sites would not be permitted in the active floodplain of a river, stream, or lake unless authorized by the AO. Gravel mining sites would also to be kept to a minimum in the planning area, and, where possible, be

designed so that fish and wildlife could use them after mining was completed. These measures would protect streams, rivers, and lakes and keep impacts to floodplains to a minimum. However, because more of the planning area would be open to oil and gas leasing under Alternative D, there would potentially be more gravel removal under this alternative than under Alternative A and B, but less than Alternative C. It is possible that 14 gravel mine sites could be necessary, impacting a total of 700 acres (See **section 4.2.1.2,** Table 4.2-G). This is greater than alternatives A and B but less than Alternative C. Lease stipulations and ROPs developed for Alternative D (described below) would be effective in reducing impacts to streams and lakes from gravel removal.

Pipelines. Types of impacts from pipeline construction and operation would be the same as those described under Alternative A. However, under Alternative D, more miles of pipeline could be constructed since more area of high oil and gas potential is open to development than under Alternative A. Under Alternative D, 482 miles of pipeline would be required resulting in short-term disturbance to soils of approximately 1,460 acres and a long-term impact at VSM sites to a total of approximately 2 acres. However, ROPs and lease stipulations for Alternative D, such as construction during the winter, would prevent or minimize impacts to water resources.

Commercial Gas Development

If commercial gas is developed on the North Slope, impacts to water resources from gas development in the planning area would be similar to those from oil development and similar to those for Alternative B. Like Alternatives B and C, Alternative D would make more lands available in the ice-rich areas especially susceptible to thermokarst, subsidence and erosion than Alternative A, and thus could have greater impacts from burying a gas pipeline. It would not have as much impact as Alternative C, however, because it would likely include few miles of buried gas pipeline. Potential impacts during burial of a gas pipeline could include temporary impoundments, diversions, and sedimentation. Buried gas lines also have potential thermokarst, subsidence, and erosion problems that could persist beyond the construction phase. If all work on the pipelines is done during winter, these impacts would be greatly reduced. Placement of the gas pipeline on VSMs would also obviate these impacts associated with pipeline burial.

4.6.4-b Surface Water and Groundwater Quality

4.6.4-b.1 Activities Not Associated With Oil and Gas Exploration and Development

Impacts under Alternative D would be expected to be similar to those that would occur under Alternative A and the other alternatives. The only types of non-oil and gas activities in the planning area that are likely to affect freshwater quality would be ongoing subsistence and recreational activities, primarily along rivers and lakes in the ACP, and use of lakes by floatplanes and watercraft. These activities have been ongoing for sometime, and impacts to freshwater quality appear to have been negligible.

4.6.4-b.2 Oil and Gas Exploration and Development Activities

Types of impacts from oil and gas exploration activities under Alternative D would be similar to those described under Alternative A. The main difference between these alternatives

pertaining to water quality is that Alternative D opens more of the planning area to exploration and development, including areas around Teshekpuk Lake. This increases the likelihood of exploration or development activities impacting water quality in the lake and surrounding areas. However, lease stipulation K-3 requires a minimum of ¼ mile setback from the Lake for oil and gas facilities and this should reduce the likelihood of a spill reaching the Lake. Teshekpuk Lake itself would be deferred from leasing. Therefore, the potential for impacts to water quality from a spill in the Lake would be less than for Alternatives B and C.

Potential surface water quality impacts for oil and gas exploration and development fall into three general source categories: accidental release of fuels and other substances (including oil spills), which could occur during both the construction and operation periods; reductions in dissolved oxygen and changes in ion concentrations in lakes used for water supply, which would occur mainly during construction but could also happen during operations; and increases in terrestrial erosion and sedimentation causing higher turbidity and suspended solids concentrations, which could occur during both the construction and operational periods. The following analysis is based on **section 4.2.1.2, *Oil and Gas Exploration and Development Activities***. See that section for a description of how estimated areas of disturbance were calculated for each alternative.

Effects of Exploration

Exploration activities that could affect water quality within the planning area under all alternatives would be seismic surveys; ice-road and ice-pad construction; and drilling-fluid storage and disposal. Oil spills would predominantly be attributable to development activities; therefore, spills will be discussed under the analysis of development impacts.

Seismic Activities and Overland Travel. Impacts to water quality from seismic surveys would be the same as those described for Alternative A. Under all of the alternatives, it is projected that three 2-D and two 3-D surveys would be done to fill in gaps in existing surveys.

Ice Road/Pad Water Use. Types of impacts from ice road/pad water use are the same as those described in Alternative A. Water use is expected to be greater than under Alternative A and similar to Alternative B. For Alternative D, it is estimated that a total of 6,200 miles of ice road would be constructed during the life of the plan impacting approximately 19,000 acres (See **section 4.2.1.2,** Table 4.2-G). In addition, 30 miles of ice runway would be constructed impacting 330 acres. However, as discussed under Alternative A, studies in other areas of the North Slope have shown that water withdrawal from lakes for ice roads and pads has not measurably affected long-term water quality (Baker, 2002; Hinzman, 2006).

Drilling Water Use and Drilling Fluids. Types of impacts from drilling water use would be the same as those described in Alternative A. However, more exploration wells would likely be needed under Alternative D. Under this alternative, it is assumed 193 exploration and delineation wells would be drilled from ice pads in the planning area. The preferred means of disposing of drilling wastes, including muds and cuttings, would be reinjection into wells, which would not cause impacts to surface water quality. Mud pits and surface discharge of exploration drilling muds and cuttings would be prohibited. Under this scenario, there likely would be a negligible impact to water quality from drilling fluids used in exploration.

Effects of Development

Development activities that could affect water quality in the planning area include spills; excavation of material sites; stream crossings; summer tundra travel; and construction of gravel roads, pads, and airstrips.

Spills. The greatest risk to water quality from oil and gas activity in the planning area is the potential for spills, with impacts dependent upon the size, season and nature of the spill. Effects of spills would be similar to those described in Alternative A. Under Alternative D, however, more of the planning area would be open to exploration and development than under Alternative A. Therefore, potential impacts to water quality from oil spills could be larger than in Alternative A as the estimated number of large and small spills is greater (see **section 4.2.2, *Oil Spills***). In addition, Alternative D allows for drilling near Teshekpuk Lake. This increases the likelihood of a spill impacting water resources and quality in this Lake. However, lease stipulation K-3 requires a minimum of ¼ mile setback from the Lake for oil and gas facilities and this should reduce the likelihood of a spill reaching the Lake. Teshekpuk Lake itself would be deferred from leasing. Therefore, the potential for impacts to water quality from a spill in the Lake would be less than for Alternatives B and C.

As noted in the 1998 Northeast IAP/EIS (USDOI BLM and MMS 1998), a small oil spill (less than 4 bbls) reaching Teshekpuk Lake would likely have a minimal effect on water quality. Dissolved oxygen levels could be affected locally. Direct toxicity would be minimal because of the much greater dilution volume in Teshekpuk Lake than in the small ponds and lakes discussed earlier, and because of the relatively unrestricted movement of the slick and underlying water. The spreading of the spill over about 60 acres (0.03% of the lake surface) would have an adverse effect on water quality in this area of the Lake. This effect would persist for a few weeks, until the slick was either cleaned up or the oil stranded on the shoreline. Similar effects would be expected if an oil spill were to reach any of the lakes in the planning area. The effects on water quality if a large spill was released directly to surface water could be large and extensive, and the magnitude of the effects would depend on the speed of cleanup response teams and the local conditions affecting oil dispersion. The probability of this type of spill occurring is very small.

Gravel Structures. Types of impacts to water quality from construction of CPFs, gravel pads, within-field roads, runways, pump stations, and staging areas would be similar to those described in Alternative A. However, under this alternative, it is estimated that 6 fields would be developed, resulting in direct impacts of approximately 3,700 acres impacted by gravel placement. It is anticipated that gravel construction would result in indirect impacts of upslope water impoundment and thermokarst erosion equivalent to at least the same area as that directly covered by gravel, or about 3,700 acres for the development assumptions made under this alternative. This is greater than alternatives A and B and less than estimates for Alternative C. Therefore, compared to Alternatives A and B, there would be a potential increase for thermokarst erosion to result in water features with high turbidity and suspended-sediment concentrations.

Additional lease stipulations for Alternative D would reduce the impact of gravel structures in some areas. The additional lease stipulations and changes would prohibit permanent oil and gas facilities except pipelines on approximately 240,000 acres north and east of Teshekpuk Lake. Finally, a new site-specific stipulation would establish a maximum limit of 300 acres of permanent surface disturbance from oil and gas activities within each of seven lease tracts identified north of Teshekpuk Lake. Theses seven lease tracts range in size from approximately 46,000 acres to 59,000 acres. These additional stipulations would help to minimize potential impacts to water quality.

Gravel Removal. Types of impacts from development of gravel sites would be the same as those described in Alternative A. Under Alternative D it is possible that 14 gravel mine sites would be necessary, resulting in a total of 700 acres impacted, depending on the actual number of sites required. More area could be affected than estimated for Alternatives A and B. Therefore, the potential is greater for impacting water quality locally by an increase in thermokarst and erosion at gravel extraction sites. ROP E-5 is designed to minimize the development footprint and would also minimize the amount of gravel and, therefore, gravel sites. ROP E-8 is designed to minimize the impact of mineral materials mining activities on air, land, water, fish, and wildlife resources. It would require that sites are located outside the active floodplain and would encourage their use for reservoirs and sites for enhancing fish and wildlife habitat. These ROPs would minimize effects to water quality from material sites.

Summer tundra travel. Given the potentially greater number of fields developed, impacts from summer tundra travel under Alternative D could also be greater than under alternatives A and B. Short-term, minor impacts are expected from limited summer tundra travel using low ground pressure vehicles. ROP L-1 is designed to regulate and monitor summer travel. Summer travel would be permitted on a case-by-case basis if the applicant can demonstrate that the proposed use would have no more than short-term impacts to soils; vegetation; and, therefore, water quality.

Stream Crossings. Types of impacts to water quality from stream crossings would be the same as those described in Alternative A. Under Alternative D, it is estimated that more roads (**section 4.2.1.2,** Table 4.2-G) would be constructed than under Alternatives A and B. Therefore, more steam crossings and drainage culverts could be necessary to reach additional areas of high oil and gas potential. The potential for constricting flows and creating increased stream velocities, ice jams, ice impacts, scour, and streambank erosion would be greater. However, lease Stipulations 42, 43, and 44 provide guidance on the use of bridges and culverts that would help ensure natural drainage patterns and water quality are maintained.

Pipelines. Types of impacts from pipeline construction and operation would be the same as those described in Alternative A. Under Alternative D, given the potentially greater number of fields developed, impacts from pipeline construction would be greater than those described for Alternatives A and B. Under Alternative D, 482 miles of pipeline would be required resulting in short-term disturbance to soils of approximately 1,460 acres and a long-term impact at VSM sites to a total of approximately 2 acres. However, ROPs and lease stipulations for Alternative D, such as construction during the winter, would prevent or minimize impacts to water resources.

The extent of impacts associated with buried pipeline could also be greater under Alternative D given the potentially greater number of fields developed than in Alternatives A and B. Because pipeline burial under tundra has been the exception on the North Slope rather than the norm, it is expected that this activity would disturb only a small amount of area in the planning area.

Effects of Abandonment and Rehabilitation

Types of effects from abandonment and rehabilitation would be the same as those described in Alternative A. Under Alternative D, given the potentially greater number of fields developed, impacts from abandonment and rehabilitation would be greater than those described for Alternatives A and B, but less than for Alternative C. See **section 4.2.1.2,** Table 4.2-G for a comparison of areas impacted by infrastructure that would need to be rehabilitated. Lease

Stipulation G-1 could require removal and reclamation of the developed site(s) upon field abandonment, which would eventually result in restoration of the natural drainage.

Commercial Gas Development

If commercial gas is developed on the North Slope, impacts to water quality from gas development in the planning area would be similar to those from oil development, except there would not be the risk of impacts from an oil spill, and similar to those for Alternative B. Like Alternatives B and C, Alternative D would make more lands available in the ice-rich areas especially susceptible to thermokarst, subsidence and erosion than Alternative A, and thus could have greater impacts from burying a gas pipeline. It would not have as much impact as Alternative C, however, because it would likely include few miles of buried gas pipeline. Potential impacts during burial of a gas pipeline could include temporary impoundments, diversions, and sedimentation. Buried gas lines also have potential thermokarst, subsidence, and erosion problems that could persist beyond the construction phase. If all work on the pipelines is done during winter, these impacts would be greatly reduced. Placement of the gas pipeline on VSMs would also obviate these impacts associated with pipeline burial.

4.6.4.3 Effectiveness of Stipulations and Required Operating Procedures

Under Alternative D, the lease stipulations and ROPs listed in Table 2-2 are expected to mitigate impacts to water resources because they would require setbacks from rivers and fish-bearing lakes for oil and gas activities, place limits on the withdrawal of water from fish-bearing lakes, and regulate the construction of gravel roads, ice roads and pads, and pipelines. Also, oil spill prevention and response procedures would be required, as would oil spill clean-up procedures. Refueling would be regulated and thereby kept away from rivers and lakes, particularly fish-bearing lakes. The required snowpack would be present on the tundra before seismic equipment would be allowed to make overland moves during winter. Drilling would not be allowed in streams, rivers, or fish-bearing lakes.

Lease stipulations and ROPs would also protect water quality under Alternative D. Required Operating Procedures A-1 through A-7 would regulate garbage, wastewater, drilling wastes, fuel and chemical storage, fuel handling, and spill prevention and clean-up plans. Required Operating Procedure B-1 would prohibit water withdrawal from rivers during winter and ROP B-2 would regulate amounts of winter water withdrawals from lakes. Required Operating Procedure's C-2 through C-4 would regulate overland moves, seismic work, ice-road construction, and other heavy equipment travel during the winter to limit impacts to water resources. Lease Stipulation D-1 would limit exploratory drilling in shallow lakes, streams, and floodplains, but would allow exceptions if there was no feasible or prudent alternative. Required Operating Procedures and Lease Stipulations E-2, E-3, E-6, and E-8 would limit certain facility, structure, and gravel mine site design and construction impacts near lakes and rivers, but would allow exceptions if there was no feasible or prudent alternative.

Lease Stipulation G-1 may require removal and reclamation of the developed site(s) upon field abandonment, which would eventually result in restoration of the natural drainage. Lease Stipulation K-1 would be equally effective as Alternative A Lease Stipulation 39 in protecting aquatic, floodplain, and riparian areas adjacent to rivers identified as having critical aquatic and riparian habitat, except in certain large rivers. Lease Stipulation K-2 would also be equally effective as Alternative A Lease Stipulation 39 in protecting aquatic and riparian areas adjacent to deep-water lakes, but would allow exceptions if there were no feasible or prudent alternative.

Lease stipulation K-3 requires a minimum of ¼ mile setback from Teshekpuk Lake for oil and gas facilities and this should reduce the likelihood of a spill reaching the Lake.

In addition, three new lease stipulations are proposed for Alternative D, and additions, deletions, and edits have been made to the proposed performance-based mitigations designed for alternatives B and C. These stipulations would increase protection to surface resources throughout the planning area. The additional lease stipulations and changes would prohibit permanent oil and gas facilities except pipelines on approximately 240,000 acres north and east of Teshekpuk Lake. Exploration activities would be allowed within this RSO, including seismic acquisition and exploratory drilling. Finally, a new site-specific stipulation would establish a maximum limit of 300 acres of permanent surface disturbance from oil and gas activities within each of seven lease tracts identified north of Teshekpuk Lake. Theses seven lease tracts range in size from approximately 46,000 acres to 59,000 acres.

4.6.4.4 Conclusion

Under all alternatives, this analysis shows that impacts to water resources from non-oil and gas activities would be minor. Most impacts from and oil and gas exploration would also be minor and short-term. Short-term impacts include water withdrawals from lakes for ice roads and ice pads. Seismic activities could result in thermokarst and erosion on approximately 153 acres during a 25-year period under all alternatives.

Under Alternative D, the amount of area impacted from oil and gas exploration and development would potentially exceed those of alternatives A and B as additional high-potential oil and gas areas would be available for leasing. Therefore, potential impacts to water resources from development infrastructure such as CPFs, roads, pads, runways, pipelines, pump stations, staging bases, and material sites would also be greater (see **section 4.2.1.2,** Table 4.2-G, for a comparison of infrastructure by alternative). Long-term impacts from development of CPFs, gravel roads, pads, runways, pump stations, and staging bases could have direct impacts of approximately 3,700 acres and indirect impacts of approximately 3,700 acres under Alternative D. Impacts could include disturbance of stream banks or shorelines and subsequent thawing of permafrost (thermokarst); and blockages of natural channels and floodways which would disrupt drainage patterns. Excavation of material sites would also result in a long-term loss of approximately 700 acres. Total long-term impacts would total 8,100 acres.

Under Alternative D, it is estimated that more roads and, therefore, steam crossings could be necessary to reach areas of high oil and gas potential than under Alternatives A and B. The potential for constricting flows and creating increased stream velocities, ice jams, ice impacts, scour, and streambank erosion would also be greater. However, lease Stipulations 42, 43, and 44 provide guidance on the use of bridges and culverts that would help ensure natural drainage pattern are maintained.

The greatest risk to water quality from oil and gas activity in the planning area is the potential for spills. Under Alternative D, the estimated number and volume of large and small spills would be greater than those estimated for Alternatives A and B since additional high oil potential areas would be available for development. Also, the potential for a spill in Teshekpuk Lake would be greater than for Alternative A. However, since leasing on the Lake itself would be deferred under this alternative, there is less potential for a spill to impact water resources in Teshekpuk Lake than for Alternatives B and C.

Impacts to water resources from non-oil and gas activities, and from oil and gas activities, would likely be additive, except in those areas where the two types of activities overlapped. Impacts to water sources from exploration and development activities would also be additive, except where development activities occurred in areas previously disturbed during exploration. In areas where two or more activities occurred, overall impacts would reflect those impacts associated with the first activity and any new impacts associated with later activities.

Numerous technological advancements have been made during the decades of operations on the North Slope that have allowed current development activities to proceed with less environmental impact than previous operations (NRC 2003). While any surface-disturbing activity or spill could affect water resources, the lease stipulations and ROPs under Alternative D would help mitigate impacts to these resources.

4.6.5 Vegetation

4.6.5.1 Activities Not Associated With Oil and Gas Exploration and Development

Under Alternative D, impacts associated with non-oil and gas activities would be similar to those described under the other three alternatives. These activities could occur throughout the planning area, and at more or less the same frequency and intensity as under the other alternatives. There could be some increased use of off-road vehicles in the planning area due to an increase in the amount of roads associated with development when compared to Alternative A. However, additional impacts to vegetation from this increase would likely be small.

4.6.5.2 Oil and Gas Exploration and Development Activities

Effects of Disturbances

Exploration

Under Alternative D, types of impacts to vegetation from activities associated with oil and gas exploration would be similar to those that occur under other alternatives. There would be a greater number of exploration and delineation wells drilled than under Alternatives A or B (less than Alternative C), which would alter the impacts of well collar construction and the number and impacts of both ice pads and ice roads.

Under Alternative D, the same scenario for seismic exploration is assumed as for the other alternatives. Short-term vegetation disturbance from 2-D and 3-D operations combined would total a maximum of 107,996 acres (2.3% of the 4.6 million acre planning area). Long-term disturbance is estimated to total 153 acres.

During the life of the plan, it is assumed that 110 exploration wells and 83 delineation wells, or a total of 193 wells, would be drilled from ice pads in the planning area under Alternative D. At six acres per pad, these would impact 1,158 acres of tundra, spread out over 50 years (28% more than Alternative A, 14% more than Alternative B and 9% less than Alternative C). Assuming that 4% (eight) of these would also involve an over-summer ice pad, an additional 48 acres of vegetation would be affected by ice pads (8% less than Alternative C, but up to 14% more than Alternatives A or B).

Ice road construction is assumed the same as for Alternative B in terms of total miles constructed. The total acreage of short term disturbance from ice roads over 50 years would be 18,672, about 20% more than for Alternative A and 17% less than Alternative C. Since vegetation recovery from ice road impacts is expected within a few years (Yokel et al. in press), long-term disturbance from ice roads would be negligible. Although some evidence of crushed tussocks may still be apparent, new growth would preclude any exposed soils.

Ice airstrips are also used during exploratory drilling, and under Alternative D it is assumed that 30 ice airstrips would be constructed covering 11 acres each for a total of 330 acres (the same as for Alternative B, 50% more than Alternative A and 33% less than Alternative C). These airstrips are commonly built on the grounded ice of large lakes, but if they were built over tundra they would result in impacts similar to ice roads.

The construction of well cellars during exploration requires the digging of a hole that destroys vegetation on approximately 16 square feet (0.0004 acres) of ground. Thermokarst associated with the disruption of thermal regime in the surrounding soil may also change the vegetation type around the well cellar to a wetter vegetation type. These impacts could result in 0.07 acres of vegetation being destroyed under Alternative D (28% more than Alternative A, 14% more than Alternative B and 9% less than Alternative C).

Development and Production

During oil and gas development and production, various activities could cause impacts to vegetation in the planning area. These activities include construction and use of gravel pads, staging areas, roads, airstrips, and pipelines, excavation of material sites, and construction of ice roads and ice pads. Ice roads and pads are covered above.

Placement of Gravel Fill. Construction of CPFs and associated satellite pads, roads, staging areas, and airstrips would result in the destruction of vegetation in the areas of gravel placement. Under this alternative, six CPFs and associated satellite pads, roads and airstrips,, and three staging bases would be developed, resulting in 3,676 acres of vegetation destroyed by gravel placement. This is about 35% more area than would be impacted by gravel placement under Alternative A, 20% more than under Alternative B, and about 5% less area than would be impacted under Alternative C.

Under Alternative D, a larger area would be impacted by dust than under Alternative A or Alternative B. However, impacts from dust would be slightly less than would occur under Alternative C, which assumes one more gravel airstrip. Assuming a total of 320 miles of in-field gravel roads and 6 miles of airstrips, there is a potential for a total perimeter of 652 miles. Within 30 feet of gravel fill, up to 2,371 acres of vegetation could be subject to smothering by dust and gravel, and another 9,484 acres could be affected by a dust shadow.

Construction of gravel pads, roads, and airstrips could alter the moisture regime of tundra near the structure by changing natural drainage patterns and areas where snow accumulates. Snowdrifts caused by gravel structures increase the wintertime soil surface temperature and increase thaw depth in soils near the structures. These impacts are exacerbated by dust deposition (described above) and by the formation of impoundments (described below). These factors could combine to warm the soil, deepen thaw, and produce thermokarst adjacent to roads and other gravel structures (NRC 2003). Additionally, these changes could alter the species composition of the plant community near gravel structures. In general, most changes in the plant community around gravel structures would occur within 164 feet of the structure. If

all effects were to occur within this zone, approximately 12,961 acres would be impacted under Alternative D (39% more than under Alternative A, 27% more than under Alternative B, and 0.3% less than under Alternative C). Note that this area includes the 11,855 acres affected by dust above, and is not in addition to it.

Material Sites. Gravel required for development in the planning area could be mined from existing sites east of the planning area or could be extracted from new sites developed within the planning area. Investigations to identify gravel sources in the planning area have not been conducted, but presumably would be initiated if discoveries of recoverable oil or gas were made. Under Alternative D it is assumed that 14 material sites, each affecting 50 acres, would be needed. This would cover a total area of 700 acres (27% more than Alternative A, 8% more than Alternative B, and 13% less than Alternative C). Excavation of gravel and stockpiling of overburden would destroy vegetation at these sites.

Pipelines. Under Alternative D, impacts from oil pipeline construction would be similar in nature to those described for the other alternatives. The total area disturbed by each VSM would be about 14 square feet. Overall, 0.03 acres of vegetation would be disturbed by VSMs per pipeline mile. Under Alternative D, 320 miles of gathering lines and 162 miles of sales-oil pipelines would disturb 15 acres of vegetation through VSM placement (23% more than Alternative A, 17% more than Alternative B, and 4% less than Alternative C). In addition, if commercial gas development occurred in the planning area, the impacts of gas pipelines would likely be the same as those described for Alternative A.

Summer Tundra Travel. On a case-by-case basis, BLM may permit low-ground-pressure vehicles to travel off of gravel pads and roads during periods other than when the ground is frozen and covered with snow. This is expected to be an uncommon occurrence, and if permitted at all it would likely be only during late summer to fall. Because of restrictions that would be placed on this activity, impacts to vegetation should be limited to the compression of standing vegetation, similar to what happens during winter following traffic by low-ground-pressure vehicles.

Air Pollution. The potential for impacts to vegetation from air pollution would be slightly greater under Alternative D than under Alternative A, less than under Alternative C, and the same as for Alternative B, given the differences in oil fields and processing facilities assumed. However, it is unlikely that impacts to vegetation from pollutants would substantially alter the plant communities in the planning area.

Effects of Spills

The greater amount of leasing, development, and production of oil that would occur under Alternative D, relative to Alternative A or Alternative B, would result in a greater number of small spills of crude and refined oil in the planning area. The chance of a large oil spill occurring would also be greater under Alternative D; however it would still be a very rare event. Impacts from spills would be less likely under Alternative D than under Alternative C.

Most oil spills cover less than 500 square feet (<0.01 acres), though a pressured aerial mist may cover up to 145 acres (Ott 1997). (Such a spill is a very low probability event, occurring less than once out of the total spills expected throughout the life of this plan. Thus its magnitude is not apparent in the following acreages). The average spill would cover 0.1 acre. If 11% of all oil spills would reach vegetation during summer, under Alternative D this would mean 252 of the 2,287 spills assumed to occur over the life of the plan would have more than a negligible effect

on vegetation. This is about 27% more than the amount that would be impacted under Alternative A. Assuming the average spill would cover 0.1 acre, under Alternative D approximately 25 acres would be impacted substantially during the lifetime of development in the planning area. This is about 26% more than the acreage impacted under Alternative A, 16% more than under Alternative B, and 10% less than under Alternative C. Overall, past spills on Alaska's North Slope have resulted in minor ecological damage and ecosystems have shown good potential for recovery (Jorgenson 1997).

Abandonment and Rehabilitation

During abandonment activities, vegetation and wetlands would be impacted by dust fallout along roads, by ice roads and other off-road tundra travel associated with dismantling of pipelines and power lines, and by disturbance to vegetation adjacent to VSMs and power line poles during their removal. The level of impact from these activities would be roughly the same as that during construction if gravel fill was removed; impacts would be less if the gravel were to be left in place. If roads and pads were left in place, and especially if cross drainage across roads was not maintained, water impoundment would occur, and could alter plant communities as described for the construction period. It is also likely that the unmaintained roads would have occasional washouts, where tundra vegetation would be covered with washed-out gravel. Roads and pads, if left in place, would likely need to be revegetated with plants native to gravel bars and ridges in the Arctic (i.e., different from the plant communities surrounding the facilities). Revegetation activities could take several years, as initial attempts are not always successful. Removal of gravel from pads, roads, and airstrips could be mandated. Partial or complete removal of gravel can result in faster reestablishment of native plant growth, although establishment can take many years (more than a decade). In addition, thaw subsidence is difficult to predict, and complete restoration to preexisting conditions is improbable. In general, impacts from abandonment and rehabilitation for Alternative D would be greater than what would occur under Alternatives A or B, and less than what would occur under Alternatives C given the numbers of fields likely to be developed under each of these alternatives.

Commercial Gas Development

The 162-mile-long buried gas pipeline projected for Alternative D (as well as Alternatives A and B) would destroy about 80 acres of vegetation directly through excavation of a 4-foot-wide trench and, potentially, alter 210 acres along an approximately 11-foot-wide strip where compaction and other indirect effects from use of machinery and temporary storage of overburden would occur. Because of the difficulty colonizing species would have invade such a wide area, a recovery time of several years or longer may be expected, though wetter areas would generally revegetate before drier areas (McKendrick, 2000). In addition, vegetation would be lost to a 10- to 20-acre compressor station pad. Placement of gas pipelines on VSMs, would generally reduce impacts to vegetation as described for Alternative A.

4.6.5.3 Effectiveness of Stipulations and Required Operating Procedures

Alternative D would have very similar lease stipulations and ROPs as those outlined under alternatives B and C, and the differences would have no effects on impacts to vegetation. Under Alternative D, development in the planning area would result in greater impacts to vegetation and plant communities compared to Alternatives A or B (but less than Alternative C), due to the different extent of gravel fill. The ROPs and lease stipulations associated with Alternative D would reduce impacts by minimizing destruction of vegetation and alteration of plant communities. Alternative D also has additional lease stipulations that limit surface occupancy

in portions of the planning area. These lease stipulations would prevent surface occupancy (except for pipelines and community-funded roads) in areas north and east of Teshekpuk Lake in the Goose Molting Area and in caribou calving and migration areas to the south and east of Teshekpuk Lake. These additional lease stipulations would also protect vegetation in these areas.

4.6.5.4 Conclusion

Under Alternative D, impacts to vegetation from activities other than oil and gas development would include minor impacts from aircraft landings, archaeological and paleontological excavations, camps, and overland moves. The duration of these impacts would be short term, ranging up to 5 months, and recovery would vary from 1 to several years. The amount of impact from these activities would be similar for all alternatives.

As for other alternatives, impacts to vegetation from oil and gas exploration would occur from seismic work and construction of well cellars during exploratory drilling and the construction of ice roads and ice pads. The duration and recovery time for impacts associated with seismic work would be similar to those for overland moves and the same as for the other three alternatives. Based on earlier studies, there should be no substantial, long-term impacts to vegetation from seismic lines, but camp move trails could substantially impact approximately 153 acres after 8-9 years. Effects of well cellar construction would also be permanent, but would impact only 1.2 acres of vegetation.

Under Alternative D, the effects of oil and gas development and operation would include destruction of vegetation during construction of gravel pads (CPFs, satellite drill pads, pump stations, and staging bases), roads, airstrips, and staging areas; from excavation of material sites and burial of gas pipelines; and construction of VSMs. These impacts would be long-term and would impact about 4,378 acres (6% less than Alternative C), or 0.1% of the 4.6 million acre planning area (as compared to 0.07% under Alternative A, 0.08% under Alternative B, or 0.1% under Alternative C). (An additional 80 acres would be destroyed through burial of gas pipelines). Plant communities could also be altered by dust deposition, salinity of gravel fill used in construction, snow drifts, and blockage of or change to natural drainage patterns. These impacts would also be long-term and would impact about 12,961 acres, or 0.3% of the planning area (39% more than the amount of vegetation impacted under Alternative A, 27% more than under Alternative B, or 0.3% less than under Alternative C).

It is assumed that impacts to vegetation types or communities would occur in proportion to their occurrence within the planning area. However, Alternative D also has several additional lease stipulations that limit surface occupancy in portions of the planning area. These lease stipulations would prevent surface occupancy (except for pipelines and community-funded roads) in areas north and east of Teshekpuk Lake in the Goose Molting Area and in caribou calving areas to the south and east of Teshekpuk Lake. These additional lease stipulations would protect vegetation in these areas, which have a higher percentage of wet vegetation communities.

Under Alternative D, development would be unlikely to substantially affect any plant species or communities. However, if development facilities were constructed in an area containing a population of a rare plant species, the impacts to that species could be severe. Three rare North Slope plant species are known to occur in the planning area, and four other rare species are known to occur on the North Slope but have not been documented in the Northeast NPR-A. Sabine grass is an aquatic grass that rarely occurs between the pendent grass and sedge zones

in lakes and ponds. This species is known from a few locations north and northeast of Teshekpuk Lake, which would be protected from development under the alternatives A and B, but would not be protected under Alternative C. Although some development would be allowed in the area north of Teshekpuk Lake under Alternative D, most areas where Sabine grass could be found would be protected by the additional lease stipulations associated with this alternative. Stipulated cinquefoil has been found at Umiat. This Asian species is found in sandy substrates, such as sandy meadows, and riverbank silts and sands other than dunes. This species would be protected by setbacks along rivers in the planning area and by the designation of the Colville River Special Area. Muir's fleabane, Drummond's bluebell, and Hartz's bluegrass all occur in dry habitats associated with bluffs, floodplains, river terraces, sand dunes, rocky outcrops and fellfields. These habitats are the primary sources of gravel fill used during construction and development (NRC 2003) and could be impacted by development in these areas.

Impacts to vegetation from non-oil and gas activities, and from oil and gas activities, would likely be additive, except in those areas where the two types of activities overlapped. Impacts to vegetation from exploration and development activities would also be additive, except where development activities occurred in areas previously disturbed during exploration. In areas where two or more activities occurred, overall impacts would reflect those impacts associated with the first activity and any new impacts associated with later activities.

4.6.6 Wetlands and Floodplains

Under the Alternative D, approximately 95% of the acreage in the planning area (approximately 4.39 million acres) would be open for leasing. Because this is substantially more acreage than under Alternative A, more wetlands and floodplains could be impacted by oil and gas activities under this alternative. However, under the Alternative D, performance-based lease stipulations and ROPs very similar to those developed for alternatives B and C would be used to mitigate the impacts of energy exploration and development on surface resources. In addition, three new lease stipulations are proposed for Alternative D, and additions, deletions, and edits have been made to the proposed performance-based mitigations designed for alternatives B and C that would apply to Alternative D and would increase protection to surface resources throughout the planning area. Setbacks from rivers, streams, and fish-bearing lakes would be in the range of ½ to 3 miles. The main difference between this alternative and the Alternative A pertaining to wetlands and floodplains is that the Alternative D allows for drilling near Teshekpuk Lake and within the Teshekpuk Lake Special Area, whereas the Alternative A does not allow for drilling near the lake. This greatly increases the likelihood of exploration or development activities impacting wetlands since over 95% of the additional acreage is considered wetlands. However, Teshekpuk Lake itself would be deferred from leasing.

4.6.6.1 Activities Not Associated With Oil and Gas Exploration and Development

Under Alternative D, the types of non-oil and gas activities would be similar to those described under the other three alternatives. Activities not related to oil and gas exploration and development that could occur in the planning area under Alternative D include aircraft, watercraft, OHV and snowmachine use, overland moves, collection and excavation for scientific research, hunting camps, recreational use of the area, and use of the area by local natives for subsistence. These activities could occur throughout the planning area, and at greater frequency and intensity than under Alternative A, because of the increased availability of land for oil and

gas leasing. For example, use of OHVs in the planning area would likely rise due to an increase in the amount of roads associated with development. However, additional impacts to wetlands and floodplains from this increase would likely be small.

4.6.6.2 Oil and Gas Exploration and Development Activities

The following analysis is based on **section 4.2.1.2, *Oil and Gas Exploration and Development Activities***. See that section for a description of how estimated areas of disturbance were calculated for each alternative.

Effects of Disturbances

Various activities associated with oil and gas exploration, development and production could impact wetlands and floodplains in the planning area. These activities include seismic operations, exploration drilling, construction of ice roads and ice pads, summer tundra travel, gravel roads, gravel pads for pump stations, CPFs, and staging bases, airstrip and pipeline construction, and gravel mine sites.

Exploration

During oil exploration, various activities could cause impacts to wetlands and floodplains in the planning area. These activities include seismic operations, exploration drilling, construction of ice roads, pads and airstrips. The types of impacts to wetlands and floodplains from exploration activities were described in Alternative A and are similar for all Alternatives.

Under Alternative D, impacts to wetlands and floodplains from activities associated with oil and gas exploration would be greater than those that occur under Alternative A and B, but less than Alternative C, which would increase the impacts of well cellar construction and the number and impacts of both ice pads and ice roads.

Under Alternative D, the same scenario for seismic exploration is assumed as for all other Alternatives. Short-term vegetation disturbance from 2-D and 3-D operations is expected to total a maximum of 108,000 acres. Long-term disturbance is estimated to total 153 acres.

During the life of the plan, it is assumed that 110 exploration wells and 83 delineation wells, or a total of 193 wells, would be drilled from ice pads in the planning area under Alternative D. At six acres per pad, these would impact 1,158 acres of tundra, spread out over 50 years. This compares with 906, 1,020, and 1,260 acres of impacts from Alternatives A, B, and C, respectively. Assuming that 4% (eight) of these would also involve an over-summer ice pad, an additional 48 acres of vegetation would be affected by ice pads.

The total acreage of ice roads for Alternative B and D over 50 years would be 18,672, assuming a 25-foot width for ice roads. This compares with 15,642 and 21,763 acres of impacts from Alternatives A and C, respectively. This also represents the total short-term disturbance from ice roads. Since vegetation recovery from ice road impacts is expected within a few years, it is assumed that long-term disturbance from ice roads would be negligible.

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Ice airstrips are also used during exploratory drilling, and under Alternative D it is assumed that 30 ice airstrips would be constructed (10 more than Alternative A, the same as Alternative B and 10 less than Alternative C) covering 11 acres each for a total of 330 acres. These airstrips

are commonly built on the grounded ice of large lakes, but if they were built over tundra they would result in impacts similar to ice roads.

The construction of well cellars during exploration requires the digging of a hole that destroys vegetation on approximately 16 square feet (0.00037 acres) of ground. Thermokarst associated with the disruption of thermal regime in the surrounding soil may also change the vegetation type around the well cellar to a wetter vegetation type. The impacts from 193 wells could result in 0.07 acres of vegetation being destroyed under Alternative D.

Development and Production

During oil development and production, various activities could cause impacts to wetlands in the planning area. These activities include construction of gravel pads for pump stations, staging bases and CPFs, roads, airstrips, pipelines, excavation of material sites, summer tundra travel, and construction of ice roads. Impacts of ice roads were discussed previously under the "Exploration" subheading and more thoroughly in Alternative A.

Placement of Gravel Fill. Types of impacts to wetlands and floodplains from placement of gravel fill were described in Alternative A. Construction of CPFs and associated satellite pads, roads, staging areas, and airstrips would result in the destruction of vegetation in the areas of gravel placement. Under Alternative D, six oil fields, six pump stations, and three staging bases would be developed, resulting in 3,676 acres of wetlands destroyed by gravel placement. This compares with 2,718, 3,064, and 3,847 acres of impacts from Alternatives A, B, and C, respectively.

The increased facilities construction and use under Alternative D would result in a larger area impacted by dust than under Alternative A and B and fewer than Alternative C. Assuming a total of 320 miles of in-field gravel roads and 6 miles of airstrips, there is a potential for a total perimeter of 652 miles. Within 30 feet of gravel fill, up to 2,371 acres of vegetation could be subject to smothering by dust and gravel, and between 30 and 150 feet, another 9,484 acres of altered vegetation for a total of 11,855 acres that could be affected by a dust shadow out to a distance of 150 feet. In general, most changes in the plant community around gravel structures would occur within 164 feet of the structure (Woodward-Clyde Consultants 1983). If all effects were to occur within this 164 foot zone, a total of 12,961 acres would be affected. This compares with 9,343, 10,178, 13,001 acres of impacts from Alternatives A, B, and C, respectively.

Material Sites. Types of impacts to wetlands and floodplains from material sites were described in Alternative A. Gravel required for development in the planning area could be mined from existing sites east of the planning area or could be extracted from new sites developed within the planning area. Investigations to identify gravel sources in the planning area have not been conducted, but presumably would be initiated if discoveries of recoverable oil or gas were made. Under Alternative D it is assumed that 14 material sites, each affecting 50 acres, would be needed. This would cover a total area of 700 acres. This compares with 550, 650, and 800 acres from Alternatives A, B, and C, respectively. Excavation of the gravel mine and stockpiling of overburden would destroy wetlands and floodplains at these sites. ROP E-8 minimizes impacts to wetlands and floodplains by placing material sites outside of floodplains, or within floodplains if water reservoirs can be utilized and fish habitat increased.

Pipelines. Types of impacts to wetlands and floodplains from pipelines were described in Alternative A. Impacts under Alternative D from pipeline construction would be similar to those described for Alternative A. The total area disturbed by each VSM would be about 14 square feet. About 6% of this area would be destroyed vegetation and subsequently replaced by

the VSM, and the remaining portion would be potentially altered in terms of community type or species composition. Overall, 0.03 acres of vegetation would be disturbed per pipeline mile. Under Alternative D, 320 miles of gathering lines and 162 miles of sales-oil pipelines would disturb up to 15 acres of vegetation through VSM placement. This compares with 12, 13, and 15 acres from Alternatives A, B, and C, respectively.

Summer Tundra Travel. Types of impacts to wetlands from summer tundra travel were described in Alternative A and are similar for all Alternatives. Given the potentially greater number of fields developed, impacts from summer tundra travel under Alternative D could also be greater than under Alternative A and B but less than Alternative C. Short-term, minor impacts are expected from limited summer tundra travel using low ground pressure vehicles. ROP L-1 is designed to regulate and monitor summer travel. Summer travel would be permitted on a case-by-case basis if the applicant can demonstrate that the proposed use would have no more than minimal impacts to soils and vegetation.

Stream Crossings. Types of impacts to floodplains and stream crossings from installation of culverts, bridges or pipelines were described in Alternative A and are similar for all Alternatives. An additional 90, 70, and 0 miles of infield gravel roads are expected under Alternative D than under Alternatives A, B and C, respectively. For this reason it is expected that more stream crossings will be needed, and the potential for constricting flows and creation of increased stream velocities, ice jams, ice impacts, scour and streambank erosion would be greater under Alternative D. However, ROP E-6 is protective of stream crossings by requiring crossings to be designed and constructed to maintain natural drainage and minimize adverse effects to natural stream flow.

Abandonment and Rehabilitation

Alternative D may require removal of structures or rehabilitation of 4,378 acres. This compares with 3,270, 3,716, and 4,649 acres from Alternatives A, B, and C, respectively. During abandonment activities, vegetation and wetlands would be impacted by dust fallout along roads, by ice roads and other off-road tundra travel associated with dismantling of pipelines and power lines, and by disturbance to vegetation adjacent to VSMs and power line poles during their removal. The level of impact from these activities would be roughly the same as that during construction if gravel fill was removed; impacts would be less if the gravel were to be left in place. If roads and pads were left in place, and especially if cross drainage across roads was not maintained, water impoundment would occur, and could alter plant communities as described for the construction period. It is also likely that the unmaintained roads would have occasional washouts, where tundra vegetation would be covered with washed-out gravel. Roads and pads, if left in place, would likely need to be revegetated with plants native to gravel bars and ridges in the Arctic (i.e., different from the plant communities surrounding the facilities). Revegetation activities could take several years, as initial attempts are not always successful. Removal of gravel from pads, roads, and airstrips could be mandated. Partial or complete removal of gravel can result in faster reestablishment of native plant growth, although establishment can take many years (more than a decade). In addition, thaw subsidence is difficult to predict, and complete restoration to preexisting conditions is improbable. Lease Stipulation G-1 would provide for the removal of all oil and gas facilities at the time of field abandonment unless the AO determined that facilities should be left in place.

Effects of Spills

The greater amount of leasing, development, and production of oil that would occur under Alternative D, relative to Alternative A, would result in a greater number of small spills of crude and refined oil in the planning area. The chance of a large oil spill occurring would also be greater under Alternative D; however, it would still be a very rare event.

Most oil spills cover less than 500 square feet (<0.01 acres), although a pressured aerial mist may cover up to 145 acres (Ott 1997). (Such a spill is a very low probability event, occurring less than once out of the total spills expected throughout the life of this Plan. Thus its magnitude is not apparent in the following acreages). See **section 4.3.5.2** under the vegetation section for a more thorough analysis of potential impacts to vegetation and wetlands from spills If 11% of all oil spills would reach vegetation during summer under Alternative D this would mean 252 of the 2,287 spills assumed to occur over the life of the plan would have more than a negligible effect on vegetation. This compares to 197, 228, and 275 estimated spills from Alternatives A, B, and C, respectively, which would have more than a negligible effect on vegetation. Assuming the average spill would cover 0.1 acre, under Alternative D approximately 25 acres would be impacted substantially during the lifetime of development in the planning area. Overall, past spills on Alaska's North Slope have resulted in minor ecological damage and ecosystems have shown good potential for recovery (Jorgenson 1997).

Commercial Gas Development

Development of commercial gas in the planning area under Alternative D would reflect the impacts described for soils, water, and vegetation and would be similar to that described for Alternative A. The same length of buried gas pipelines is projected, as well as the same impacts from construction of a 10- to 20-acre pad for a gas compressor station. Alternative D (as well as Alternatives B and C), which makes more lands available in ice-rich areas especially susceptible to thermokarst, subsidence and erosion, could have greater impacts from burying a gas pipeline. Placement of gas pipelines on VSMs, would reduce these impacts, though vegetation and soils would be destroyed at base of the VSMs, vegetation under aboveground pipelines would be impacted by shading, and ice roads that may be used during construction would have localized, short-term impacts on vegetation and during spring melting add somewhat saline water to any shallow tundra pools.

4.6.6.3 Effectiveness of Stipulations and Required Operating Procedures

Alternative D would have very similar performance-based lease stipulations and ROPs as those outlined under Alternatives B and C and be equally protective as those of the prescriptive stipulations in Alternative A. In addition, three new lease stipulations are proposed for Alternative D, and additions, deletions, and edits have been made to the proposed performance-based mitigations designed for alternatives B and C. These stipulations would increase protection to surface resources throughout the planning area. The additional lease stipulations and changes would prohibit permanent oil and gas facilities except pipelines on approximately 240,000 acres north and east of Teshekpuk Lake. Exploration activities would be allowed within this RSO, including seismic acquisition and exploratory drilling. Finally, a new site-specific stipulation would establish a maximum limit of 300 acres of permanent surface disturbance from oil and gas activities within each of seven lease tracts identified north of Teshekpuk Lake. These seven lease tracts range in size from approximately 46,000 acres to 59,000 acres. Development in the planning area would still result in impacts to wetlands and floodplains,

however, the ROPs and lease stipulations associated with Alternative D would be effective in minimizing destruction of wetlands and floodplains.

4.6.6.4 Conclusion

Under Alternative D, impacts to vegetation from activities other than oil and gas development would include minor impacts from aircraft, watercraft, OHV and snowmachine use, overland moves, collection and excavation for scientific research, hunting camps, recreational use of the area, and use of the area by local natives for subsistence. The duration of these impacts would be short term, ranging up to 5 months, and recovery would vary from 1 to several years.

Under Alternative D, impacts to wetlands and floodplains from oil and gas exploration would be greater than Alternatives A and B, but less than Alternative C. Activities that may create impacts to wetlands and floodplains include seismic work, construction of well cellars during exploratory drilling, and the construction of ice roads, pads, and airstrips. Based on earlier studies, there should be no substantial, long-term impacts to vegetation from seismic lines, but camp move trails could substantially impact approximately 153 acres after 8-9 years. Effects of well cellar construction would also be permanent, but would impact only 0.07 acres of vegetation.

The effects of oil development and operation would include destruction of vegetation during construction of gravel pads, roads, airstrips, and staging areas; from excavation of material sites; and construction of VSMs. These impacts would be long-term and would impact about 4,378 acres, or 0.1% of the 4.6 million acre planning area. This compares with 3,270, 3,716, and 4,649 acres of impacts from Alternatives A, B, and C, respectively. Wetland plant communities could also be altered by dust deposition, salinity of gravel fill used in construction, snow drifts, and blockage of or change to natural drainage patterns. These impacts would be also be long-term and would impact about 12,961 acres, or 0.3% of the planning area. This compares with 9,343, 10,178, and 13,001 acres of impacts from Alternatives A, B, and C, respectively.

It is assumed that impacts to wetlands and floodplains would occur in proportion to their occurrence within the planning area. However, increased development in the area around Teshekpuk Lake, and across the 213,000 acres that would be off-limits to oil and gas leasing and development under Alternative B but would be open to leasing under Alternative D, could disproportionately impact wet vegetation classes. A higher percentage of wet vegetation communities occur in areas in the northern portion of the planning area. This area is also considered to have the highest potential for oil reserves, which would increase the likelihood that these areas would be developed under Alternative D.

Impacts to wetlands and floodplains from non-oil and gas activities, and from oil and gas activities, would likely be additive, except in those areas where the two types of activities overlapped. Impacts to vegetation from exploration and development activities would also be additive, except where development activities occurred in areas previously disturbed during exploration. In areas where two or more activities occurred, overall impacts would reflect those impacts associated with the first activity and any new impacts associated with later activities.

4.6.7 Fish

4.6.7-a Freshwater and Anadromous/Amphidromous Fish

4.6.7-a.1 Activities Not Associated With Oil and Gas Exploration and Development

It is expected that the frequency and intensity of most non-oil and gas activities occurring under Alternative D would be similar to those occurring under the other alternatives. Compared to the other alternatives, ground camps in support of research may increase or decrease proportionally in association with the projected amount of oil and gas activity, and subsistence fishing could potentially occur in more or fewer areas, depending on the level of access. However, the difference in potential impacts would likely be immeasurable.

4.6.7-a.2 Oil and Gas Exploration and Development Activities

Effects of Disturbances

Effects from Seismic Surveys. Extrapolation of current 2D and 3D seismic data gathering techniques suggests that the entire area could be covered by a level of effort similar to that described for alternatives B and C. There would be 250 miles of additional 2-D surveys and two to five additional 3-D surveys relative to Alternative A. As a result, seismic activities associated with Alternative D would be expected to have the same overall effect on fish as discussed for the other alternatives—no measurable effect on Arctic fish populations. Because of the larger potential scope of development under Alternative D relative to Alternative A, the number of fuel spills during seismic surveys is expected to be higher. However, the amount of fuel entering fish habitat is not expected to increase significantly since spills are expected to be small (< 5 gallons). Fuel spills associated with Alternative D are expected to have the same overall effect on fish populations as discussed for Alternative A (i.e., no measurable effect on Arctic fish populations).

Effects from Seismic Surveys in Teshekpuk Lake. Under Alternative D, Teshekpuk Lake would be deferred from leasing. The deferral would preclude exploratory drilling and pipeline construction, but would allow seismic exploration. Under Alternative D, seismic exploration in Teshekpuk Lake could occur during the summer open water period using airgun arrays and explosives (although the use of explosives is unlikely). Impacts from Vibroseis and airgun arrays under Alternative D would be similar to those for the other alternatives.

Explosives, in comparison to airguns and Vibroseis, are generally more detrimental to fish (Wright and Hopky 1998). The received impulse depends on the mass of the charge, the depth of the charge, the distance from the charge to fish, and the depth of the fish. The peak pressure generated by an airgun array is less than that produced by a small charge of explosives. Most blast injuries to fish involve damage to air or gas-containing organs (Yelverton 1981). All of the species of fish present in Teshekpuk Lake have swim bladders and would be vulnerable to explosives. During exposure to shock waves, the swim bladder oscillates and may rupture, causing hemorrhages in nearby organs. In extreme cases the oscillating swim bladder may rupture the body wall of the fish. The use of explosives in Teshekpuk Lake would likely result in the mortality of some fish present in the lake. The number of fish impacted would depend on the frequency and size of the charge used and the location of charges relative to fish in the lake.

Effects from Water Demand. Construction-related activities that could affect Arctic fish include water withdrawal needed for the construction of drill pads, roads, airstrips, and exploratory drilling. Under Alternative D, it is anticipated that up to 110 exploratory wells and up to 83 delineation wells would be drilled (Table 4.2-E), for a total of up to 193 wells on ice pads. Assuming that the average ice pad is 500 feet by 500 feet (5.7 acres), water needs equate to approximately 2 million gallons per drill pad, for a total of up to 386 million gallons. Each mile of ice road requires up to 1.5 million gallons of water to construct. It is assumed that zero to two ice roads, 25 to 50 miles long, would be built each season for a maximum annual water requirement of 150 million gallons (same as Alternative B). Water needed for the maximum of four drilling rigs, associated camps and airstrips, and maintenance of roads, pads and airstrips would add another 119 million gallons to the annual water use budget. The total annual maximum water would be on the order of 435 million gallons, or about a 13% increase over Alternative A (384 million gallons).

Under Alternative D, greater levels of water withdrawal would be expected, in conjunction with increased exploration and development activities, relative to Alternative A. However, adherence to lease stipulations and ROPs should help mitigate impacts to fish. Alternative D would offer slightly less protection to ninespine stickleback and Alaska blackfish than Alternative A.

Assuming that the Authorizing Officer follows the common practices when approving water withdrawals, lake water withdrawals associated with Alternative D may kill small numbers of fish, but would not be expected to have a measurable effect on arctic fish populations throughout the planning area.

Effects from Exploratory Drilling. Under Alternative D, the general level of protection to fish and fish habitat offered by ROPs and lease stipulations would be similar to those developed for Alternative A and Alternative B. The number of exploratory wells could increase under Alternative D relative to Alternative A and Alternative B, but would be fewer in comparison to Alternative C. Regardless of the number of wells, the prohibition of drilling in rivers and streams should provide fish with adequate protection. Therefore, exploratory drilling activities associated with Alternative D should not have a measurable effect on freshwater, anadromous, or amphidromous fish populations within and adjacent to the planning area.

Effects from Gravel Extraction. Required Operating Procedure E-8 is synonymous with Lease Stipulation 40 of Alternative A. Both are intended to minimize the effects of gravel mining on fish by limiting gravel mine sites within the active floodplain of any river, stream, or lake unless the action enhances fish habitat. Gravel deposits are limited within the planning area and importation from outside sources could further reduce mining activities. Equivalent protection is provided for fish and fish habitat under all alternatives. No alternatives are expected to have a measurable effect on freshwater, anadromous, and amphidromous fish populations in and adjacent to the planning area, and may have a positive effect by creating new overwintering areas.

Effects from Pad, Road, and Pipeline Construction. Impacts from sedimentation and altered flow patterns associated with the construction of drill pads, roadways and airstrips are similar to those described for Alternative A. Impacts from erosion would be short term. The proper placement and design of bridges and culverts, in combination with adequate and properly sited drainage systems, should minimize impacts to anadromous/amphidromous and freshwater fish.

Effects from Summer Tundra Travel. The use of low-ground-pressure vehicles for tundra travel during the summer may be necessary for pipeline inspection, maintenance, and spill prevention activities. Under Alternative D, the same protections would be provided for fish as in Alternatives B and C (L-1 ROP), and the potential for an impact would be similar to Alternative B because of the similar length of pipeline projected. Summer tundra travel under Alternative D should not have a measurable effect on freshwater, anadromous, or amphidromous fish populations within and adjacent to the planning area.

Effects from Causeways. BLM discourages the use of solid-fill causeways, instead preferring alternatives including onshore directional drilling, elevated structures, or buried pipelines. Lease Stipulation 30 prohibits the construction of causeways, docks, artificial gravel islands, and bottom-founded structures in river mouths and deltas, and artificial gravel islands and bottom-founded structures in active stream channels, unless otherwise approved by the AO on a site-specific basis. Under Alternative D, the general level of protection to fish and fish habitat offered by ROPs and lease stipulations would be nearly identical to those for the other alternatives. The future construction of a causeway or dock could have a minor effect on anadromous, and amphidromous fish populations under Alternative D.

Effects from Waterflooding. Under Alternative D, oil fields in the northern portion of the planning area are likely to receive seawater from facilities already serving fields in the Prudhoe Bay/Kuparuk area. These facilities have been operational for years and have been shown to have no serious adverse affect on fish migrating or foraging in the intake area (see Alternative A, Effects from Waterflooding). If seawater intake facilities are constructed in the future to enhance supply to oil fields in the planning area, it is assumed that the same design safeguards would be incorporated to prevent the entrainment and impingement of fish. Waterflooding under Alternative D is not expected to have a measurable effect on anadromous and amphidromous fish population within the planning area, regardless of any increase in exploration and development activities. Nonetheless, under this alternative, it is projected that impacts to fish from seawater facilities would be greater than under other alternatives, except for Alternative C.

Effects of Abandonment and Rehabilitation

Water withdrawal and removal of bridges, culverts, and bridge approaches could have impacts on fish similar to those described for construction activities. Additional fish habitat could be created by allowing gravel pits to be colonized by fish from nearby streams. Because of the relative amount of infrastructure anticipated under Alternative D, it is expected that the impacts of abandonment and rehabilitation will be greater compared to Alternative A.

Effects of Spills

Under Alternative D, the general level of protection to fish and fish habitat offered by ROPs and lease stipulations would be nearly identical to those discussed under the other alternatives. Potential impacts are the same as those described under Alternative A. However, designation of RSO areas by Lease Stipulations K-4(h), K-9, K-10, and K-11 would help protect fish in lakes and streams in those areas from potential impacts of oil spills.

Under Alternative D, the volume of spills and expected amount of impact would increase proportionately (from Alternative A) with increased exploration and development. In Alternative D, the volume of oil from small and large spills is projected to be 27% more than the volume from spills estimated to occur under Alternative A. This is more than Alternative B, but

less than Alternative C. Given the small volume of oil typically involved in small spills, as well as the safety requirements for operations in the oil field and stringent clean-up protocols, small oil spills associated with Alternative D would not likely have a measurable effect on freshwater, anadromous, or amphidromous fish populations in or adjacent to the planning area. Besides the effectiveness of the response, many independent factors will determine the probability that fish will be negatively impacted by an oil spill, including the quantity spilled, season, weather patterns, location (e.g. upland versus river channel), and proximity to sensitive habitat (see **4.2.2.3, *Fate and Behavior of Spilled Oil***). If a large spill of crude oil occurred during the summer open-water period and within a major stream or river channel, this could potentially have an effect on freshwater, anadromous, or amphidromous fish populations in or adjacent to the planning area; in particular, impacting subpopulations at the drainage level. A very large oil spill within a major stream or river channel during the summer would have an even more likely impact on freshwater, anadromous, or amphidromous fish populations in or adjacent to the planning area.

Commercial Gas Development

Impacts of commercial gas development under Alternative D would be similar to those described for Alternatives A and B and slightly less that those for Alternative C. Winter construction of a buried gas pipeline by trenching through fish inhabited streams or portions of streams not frozen to the bottom would impact fish to some degree, depending on the volume of the overwintering habitat and the density of fish utilizing this habitat. Potential impacts to fish associated with maintenance of gas pipelines would be similar to those described for construction. Water withdrawals and changes to hydrology caused by ice roads could affect fish. Potential issues include losing access to suitable habitat, barriers to movement, or habitat degradation. These ice roads would be necessary during both natural gas exploration and construction phases. For example, ice roads would be used to reach exploration drilling sites and also used in trenching the pipeline route or construction of a compressor station (ADNR, 2006b). If a buried gas pipeline ruptured and gas escaped to a fish-bearing waterbody, some fish in the immediate vicinity might be killed. Natural gas and condensates would be hazardous to any organisms exposed to high concentrations. In general, very few fish are likely to be affected by a pipeline rupture.

While natural gas exploration and development may have notable localized impacts, it is not likely to have a measurable effect on freshwater fish populations.

4.6.7-a.3 Effectiveness of Stipulations and Required Operating Procedures

The effectiveness of lease stipulations and ROPs in protecting freshwater, anadromous, and amphidromous fish and fish habitat under Alternative D are similar to lease stipulations developed for Alternative A.

4.6.7-a.4 Conclusion

Construction of pads, roads, airstrips, and fuel spills associated with Alternative D might kill a small number of individual fish, but these activities are not expected to have a measurable effect on Arctic fish populations. Higher water demand relative to Alternative A would potentially place greater numbers of fish at risk, although limits on withdrawal and monitoring of water quality should minimize concerns. The greater extent of exploration activity under Alternative D (as compared to Alternative A) represents a correspondingly higher water budget. Gravel extractions within the planning area are likely to be minimal and, if they did occur

under the proper siting and design criteria, could lead to habitat enhancement under certain situations. Seismic surveys, non-oil and gas activity, causeways, and seawater spills associated with Alternative D are not expected to have a measurable effect on Arctic fish populations in the planning area over the production life of the field. Overall, potential impacts to fish are greater under Alternative D than under Alternative A or Alternative B.

4.6.7-b. Marine Fish

4.6.7-b.1 Activities Not Associated With Oil and Gas Exploration and Development

Most non-oil and gas activities, including recreational fishing, would be quite limited in scope and duration. In addition, recreational and commercial fishermen do not target marine fish in the Beaufort Sea. Therefore, it is not expected that non-oil and gas activities occurring under the Alternative D would have a measurable effect on marine fish in the vicinity of the planning area.

4.6.7-b.2 Oil and Gas Exploration and Development Activities

Effects of Disturbances

Effects from Seismic Surveys. Seismic surveys could be conducted within the planning area during the winter months, from early December to mid-May and on Teshekpuk Lake during the summer. Because marine fish and their habitat lie outside the planning area in winter and Teshekpuk Lake during the summer, seismic activities associated with Alternative D would not be expected to have a measurable effect on marine fish populations.

Effects from Water Demand. Water used in the building of drill pads, roads, and airstrips would likely be withdrawn from freshwater sources proximal to the site of construction. These activities would have no effect on marine fish or their environment. Water withdrawal for the purposes of waterflooding, which would have implications for the marine system, is discussed separately below under the "Effects from Waterflooding" subheading.

Effects from Exploratory Drilling. Most exploratory drilling would be conducted within the planning area during the winter months, from early December to mid-April. Because marine fish and their habitat lie outside the planning area in winter, most exploratory activities associated with Alternative D would not be expected to have a significant effect on marine fish populations. Exploratory drilling could also be conducted from current production pads or platforms within a lake body during summer in the TLCH Area, but impacts to marine fish would be minor.

Effects from Gravel Extraction. It is doubtful that gravel extraction would be permitted along the coastal tidal zone. Small numbers of fourhorn sculpin and Arctic flounder could migrate upriver in summer, but any encounter with a gravel site would be a chance occurrence, and would involve only a minor segment of any population. Fourhorn sculpin and Arctic flounder regularly inhabit and forage in highly turbid coastal waters near river outfalls and plumes. Gravel extraction would not benefit fish populations by creating overwintering habitat, as it might for freshwater fish, since all marine fish overwinter at sea.

Effects from Pad, Road, and Pipeline Construction. Under Alternative D, a greater number of pads, roads, and pipelines associated with expanded exploration and development activities relative to Alternative A would occur, primarily inland rather than in coastal areas. The construction of pads, therefore, is not expected to have a significant effect on marine fish populations within and adjacent to the planning area under Alternative D. Under Alternative D, the general level of protection to freshwater, anadromous, and amphidromous fish and fish habitat offered by ROPs and lease stipulations for this alternative would be less than those developed for Alternative A.

Effects from Causeways. Under Alternative D, restrictions on the use, design, and monitoring of causeways that might be constructed along the coast in the future would be nearly identical to those discussed under Alternative A. Any future construction of causeways or docks would not be expected to have a measurable effect on marine fish populations within and adjacent to the planning area even if there were a greater level of activity associated with exploration and development, relative to the other alternatives.

Effects from Waterflooding. Under Alternative D, waterflooding is not expected to have a significant effect on marine fish, for the same reasons given above for anadromous and amphidromous fish, even if there were a greater level of activity associated with exploration and development, relative to the other alternatives.

Effects of Spills

The threat to marine fish from an oil spill is contingent upon the spill reaching coastal waters at volumes capable of affecting large nearshore areas. Because oil spills in the planning area are expected to be small, and given the stringent oil-spill-response safety requirements for operations on the oil field, there is a minor likelihood that an inland spill would reach coastal/marine waters of the planning area at volumes capable of causing a biologically measurable impacts to marine fishes.

Commercial Gas Development

Marine fish populations are not expected to be affected by exploration, construction, or maintenance activities associated with a gas development beyond what is expected to occur during oil development.

4.6.7-b.3 Effectiveness of Stipulations and Required Operating Procedures

Under Alternative D, the general level of protection to fish and fish habitat offered by lease stipulations and ROPs would be similar to those under Alternatives B and C. Lease Stipulation K-6 specifically prohibits permanent oil and gas development within ¾ mile inland from the coastline, unless the AO grants an exception. Thus, greater protection is afforded marine fish under Alternative D than Alternative A.

4.6.7-b.4 Conclusion

In general, marine fishes of the Beaufort Sea are insulated from many potential environmental impacts associated with oil and gas development in the planning area. Most of the coastal tidal area of the planning area is shallow and lies within the winter landfast ice scour zone. Thus, the marine habitat and the fish occupying it are outside the planning area proper during winter and

would not be subject to disturbances associated with seismic surveys, exploration drilling, and water withdrawal. Although species like fourhorn sculpin and Arctic flounder may move upriver during summer, most members of these marine species remain in shallow coastal waters. The bulk of the population would not be directly subject to the effects of river gravel extraction; pad, road, and pipeline construction; sedimentation from gravel erosion; and the potential blockage of migratory corridors.

Because marine species are abundant and widely distributed throughout the Beaufort Sea, it is also highly unlikely that any point impact associated with oil and gas development in the planning area (the occurrence of which is unlikely) could substantially affect these marine species at the population level. One exception might be a catastrophic oil spill that could cause sublethal genetic or physiological abnormalities that might be propagated through the broader population. However, given that oil spills in the planning area are expected to be small, and the stringent oil-spill-response safety requirements for operations on the oil field, such an event is unlikely.

Overall, impacts to marine fish resources under Alternative D would be greater than those that would be expected to occur under Alternative A and Alternative B.

4.6.8 Birds

This section discusses the potential effects to bird species, which are not threatened or endangered, that could result from management actions in the planning area under the Alternative D. A discussion of effects to threatened and endangered bird species is given in **section 4.4.10, *Threatened and Endangered Species*.** Most of the activities that could potentially affect birds in the planning area would result from oil and gas exploration and development. Other activities that could potentially affect birds in the planning area include subsistence activities (including hunting, fishing, berry picking etc.), recreational use, activities associated with scientific surveys and research camps, clean up of old oil and gas exploration sites, and activities associated with government actions (e.g. clean up of abandoned well sites). These activities could affect tundra nesting birds by causing: 1) temporary or permanent habitat loss; 2) various types of disturbance related to equipment and facility noise, vehicular and air traffic, and pedestrian activities, which could result in displacement from preferred foraging, staging, nesting and/or brood-rearing habitats or decreasing productivity and survival; 3) increased predation from predators attracted to areas of human activity; and 4) mortality resulting from collisions with vehicles or structures, or exposure to contaminants, including oil spills. Alternative D makes available approximately 95% (approximately 4,389,000 acres) of the planning area's 4.6 million acres for oil and gas leasing (Map 2-4). Management practices would emphasize performance-based stipulations and ROPs on surface activities, consultation with local residents, and coordinated scientific studies to protect wildlife habitat, subsistence use areas, and other resources. Under Alternative D, Teshekpuk Lake (approximately 211,000 acres) would be deferred from leasing. This deferral would preclude exploratory drilling and pipeline construction. Current leases are not affected by the deferral.

4.6.8.1 Activities Not Associated With Oil and Gas Exploration and Development

Under Alternative D, activities not related to oil and gas exploration and development that could affect birds in the planning area would be the same as those described under the other alternatives: private or commercial air traffic, aerial surveys to inventory wildlife or other resources, summer research camps, hazardous material or debris removal, subsistence hunting

and fishing, and recreational camps and boating activity. Impacts to birds under Alternative D could be more frequent, greater in extent, or longer in duration than those occurring under Alternative A. A greater number of individual animals would be exposed to human activities. Aircraft traffic would more often pass over birds during flights to or from the camps and along aerial survey routes. The disturbance reactions of birds would likely be brief, lasting for a few minutes to an hour. Some birds might avoid inventory survey and recreation camps during the 6 to 12 weeks of activities, while ravens could be attracted to the camps. The potential for disturbance, displacement, or mortality from non-oil and gas related activities, would likely be similar under the various alternatives. Lease stipulations to protect waterfowl, shorebirds, raptors, and other birds and their habitats would help to mitigate the potential effects of non-oil and gas activities on birds under Alternative D.

4.6.8.2 Oil and Gas Exploration and Development Activities

Effects of Disturbances

Exploration

Most seismic surveys to collect geological data and exploration drilling activities would occur during the winter months when birds are mostly absent from the planning area. Under Alternative D, the types of effects of winter exploration activities on the bird species present in the planning area during the winter would be the same as those discussed under the other alternatives. Although impacts associated with winter exploration would likely be minor under any alternative, exploration could occur in the central portion of the Goose Molting Area under Alternative D that is closed to development under Alternative A and Alternative B. Conversely, small portions of the western and southeastern Goose Molting Area that are not protected under Alternative B would receive some protection under Alternative D. The direct effects of exploration would likely include the temporary displacement of a small number of birds (ptarmigan and gyrfalcon) from preferred winter feeding or roosting areas.

During winter exploration activities, indirect impacts to birds could result from the construction of ice roads and ice pads and the associated water withdrawal. The types of effects that could result from ice road and ice pad construction under Alternative D would be the same as those described under the other alternatives, and would primarily involve the temporary alteration of tundra habitats. Water withdrawal for ice road construction could also temporarily alter habitats adjacent to water source lakes, which could affect nesting or brood-rearing loons and waterfowl. Rolligons and track vehicles used during winter exploration could also temporarily affect tundra vegetation, resulting in minor impacts to tundra-nesting birds. Currently there is little known as to why geese use the Goose Molting Area in such large concentrations and impacts to vegetation or impoundments and delayed drainage due to ice roads may have a negative effect on the habitat used by molting geese. Although exploration could occur in portions of the Goose Molting Area that are closed to oil and gas leasing under Alternative A and Alternative B, other portions of the Goose Molting Area that are open to development under Alternative B would receive some protection under Alternative D.

Under Alternative D, exploration activities in Teshekpuk Lake would be deferred, thus delaying the potential for seismic exploration activities to impact birds. The use of airguns for boat-based seismic work in Teshekpuk Lake during the summer could temporarily displace loons and waterfowl from preferred feeding habitats while surveys were being conducted. Disturbance may result not only from airgun use but also from boat activity (Rodgers and Smith 1995). Because setbacks around the perimeter of the lake presumably would eliminate the potential for

disturbance to birds nesting near the lakeshore, only birds using habitats in the open water of the lake would potentially be disturbed. Birds displaced by seismic activities would likely return to preferred habitats after the airgun arrays passed through the area. Effects of use of airguns on forage fish may include stress from fleeing behavior and physical damage or death (**section 4.1.1** this document) potentially resulting in a reduction in the amount of prey available to foraging loons. Disturbance to birds near and nesting on the shoreline could result from support activities, such as use of helicopters to transport personnel and supplies. Disturbance related to support activities could result in permanent or temporary displacement from nesting, feeding, or brood-rearing habitats. Conducting surveys after the completion of the nesting, molting and brood-rearing period would eliminate the potential for nest abandonment and loss of productivity.

Predators, such as glaucous gulls, ravens, and Arctic foxes, could be attracted to anthropogenic food sources associated with summer maintenance of exploratory drilling and seismic equipment or winter exploratory activities. Increased levels of predation could have moderate impacts on tundra-nesting birds. Under Alternative D, ROPs A-2 and E-9 would help mitigate the potential effects of increased predation, and the overall effect to birds would likely increase incrementally as the amount of exploratory activity increases under the four alternatives. However, it would likely be difficult to prevent ravens from nesting on oil field structures and increased levels of predation from ravens may be difficult to mitigate under any alternative.

Oil and Gas Development

Activities on Roads and Pads. Activities related to oil development and production in the planning area, such as vehicle, aircraft, pedestrian, and boat traffic; routine maintenance activities; heavy equipment use; and oil spill clean-up activities could cause disturbances that would affect tundra-nesting birds. Under Alternative D, these types of disturbances to birds would be the same as those discussed under the other alternatives. These disturbances could result in temporary displacement from preferred foraging, nesting, and/or brood-rearing habitats; decreased nest attendance or nest abandonment; and increased energy expenditures that could affect physiological condition, rate of survival, and productivity of birds. The likelihood for impacts to tundra-nesting birds would depend on the location of the disturbance, the bird species and the number of individuals in the area, and the time of year. The greatest potential for impacts from disturbance would most likely occur in habitats with high bird concentrations, such as the Teshekpuk Lake Goose Molting Area, or if species with low or declining populations, such as buff-breasted sandpiper or yellow-billed loon, were disturbed.

The potential for disturbance to birds from activities on roads and pads would likely be greater under Alternative D, as compared to Alternatives A and B, because Alternative D roads would be permitted throughout most of the Goose Molting Area and pads would be permitted in portions of the Goose Molting Area that were closed to development under Alternative B. Under Alternative D, restricted surface occupancy, including the construction of roads, would be permitted in the caribou migration corridor between Teshekpuk Lake and the Kogru Inlet (pipelines would be allowed after the best corridor had been identified via a workshop process, see Stipulation K-5a). An RSO area would also be established southeast and southwest of Teshekpuk Lake covering 233,000 acres identified as an important caribou calving area which will allow pipelines but not allow roads. Restricting surface occupancy in this area would also help reduce impacts to birds using the area.

Alternative D would likely increase the risk of disturbance to internationally significant populations of molting geese, particularly brant that use the Goose Molting Area when

compared to alternatives A and B. The reduction in protection under Alternative D could also affect white-fronted, lesser snow and Canada geese. Disturbance that resulted in a reduction in the breeding success and survival during molting of geese and other waterfowl could also impact the success of subsistence and sport hunters in Alaska, the lower 48 states, Canada, Russia, and Mexico. Disturbance effects could also impact shorebirds if development occurred in areas of high shorebird concentration located north of Teshekpuk Lake. Lease Stipulation K-6 would establish a ¾-mile buffer inland from the coast, within which oil and gas facilities would be prohibited to the extent practicable to minimize hindrance or alteration of caribou movement within caribou coastal insect-relief areas. This lease stipulation could also help to reduce the potential impacts to waterfowl and their habitats in coastal areas.

Under the Alternative A, no permanent oil and gas facilities would be permitted within ¼ mile of the perimeter of any fish-bearing lake in the Deep Water Lakes Area south of Teshekpuk Lake. Under Alternative D, facilities would generally not be permitted within this buffer, but could be permitted, on a case by case basis, in consultation with Federal, state, and NSB regulatory and resource agencies. Permitting facilities within the ¼-mile buffer of fish-bearing lakes in the Deep Water Lakes Area could result in disturbance to yellow-billed loons and waterfowl near the facilities and access roads. However, other bird groups could also be disturbed if facilities were located outside the ¼-mile buffer. The extent of effects to birds from activities on roads and pads would depend on the species and numbers of individuals occurring in areas adjacent to the development. Although Lease Stipulation K-2 has been designed primarily to provide mitigation for deepwater fish habitat, it would also provide protection for birds using habitats near these lakes.

Summer Tundra Travel. Alternative A allows summer tundra travel in Northeast NPR-A only through use of the stipulation exception process (see stipulation 24i in the 1998 Northeast NPR-A ROD). Travel off of gravel pads is easiest in winter and generally environmentally preferable at that time, some vehicle travel off of pads does occur in North Slope oil fields during summer to accomplish specific tasks. The State of Alaska has approved some low-ground-pressure vehicles for summer tundra travel and similar summer tundra travel may be anticipated to be part of oil development in northeast NPR-A. Alternative D contains Required Operating Procedure L-1 which was crafted with the following objective "Protect stream banks and water quality;...maintain populations of, and adequate habitat for birds, fish, and caribou and other terrestrial mammals; and support maintenance of subsistence activities." Summer tundra travel is commonly associated with spill prevention and preparedness measures required in spill prevention plans and it is anticipated that these are the types of activities that would be permitted to travel off of gravel pads and roads during times other than those identified in ROP C-2a if required surveys and studies show that minimal impacts to the resources in the area would occur. The potential for disturbance to birds from summer tundra travel would likely be greater under Alternative D, as compared to Alternatives A and B but less than under Alternative C, because there are greater areas that support high bird concentrations in portions of the Goose Molting Area that would be available for oil and gas leasing under Alternative D as compared to Alternatives A and B. The reduction in the amount of habitat protected under Alternative D, as compared to Alternative A and B, would increase the risk of disturbance to internationally significant populations of molting geese, particularly brant that use the Goose Molting Area. The additional areas available for leasing under Alternative D could also affect white-fronted, lesser snow and Canada geese. Disturbance that resulted in a reduction in the breeding success of geese and other waterfowl could also impact the success of subsistence and sport hunters in Alaska, the lower 48 states, Canada, Russia, and Mexico. Disturbance effects could also impact shorebirds if development occurred in areas of high shorebird concentration located north of Teshekpuk Lake.

Air Traffic. Both fixed-wing aircraft and helicopters could be used to transport personnel, supplies, and equipment to airstrips or staging areas during development and production activities in the planning area. The types of disturbance effects to waterfowl and other bird groups from aircraft would be the same under Alternative D as those discussed under the other alternatives, and could include displacement from preferred feeding habitats, temporary or permanent nest abandonment, and temporary or permanent displacement from molting or brood-rearing areas. However, some birds could habituate to aircraft activity and either remain in habitats located near aircraft activities, or move to nearby habitats. This may not be the case for brant, as they apparently do not habituate well to aircraft traffic (Derksen et al. 1992). Aircraft disturbance to brant may cause behavioral and physiological responses that could increase energy expenditures and reduce foraging time, which could increase the duration of the flightless period and susceptibility to predation. Birds could be displaced from optimal to sub-optimal habitats, causing birds to spend more time foraging to meet nutrient needs (Derksen et al. 1992).

Under Alternative D, there would be the potential for a greater amount of disturbance to birds from aircraft activity in most of the Goose Molting Area as compared to Alternatives A and B. This is due to the potential for placement of facilities in the central portion of the Goose Molting Area, which is not open to oil and gas leasing and development under Alternatives A and B. Under Alternative D, however, development would not be permitted in portions of the western, southeastern, and north coastal Goose Molting Area that are open to development under Alternative B, which could reduce the potential for aircraft disturbance to birds in these areas. Confounding the issue is the potential for pipeline construction throughout most of the Goose Molting Area, which would result in the potential for helicopter surveillance for pipeline inspection.

Although set-backs from the goose molting lakes would provide a buffer within which facilities could not be located, continual aircraft flights into facilities located between buffer zones would have the potential to disturb molting geese. Aircraft disturbance could have moderate impacts on tundra nesting waterfowl and shorebirds under Alternative D. Impacts may be greater on molting and brood-rearing brant and other geese that apparently do not habituate well to some types of aircraft traffic. Helicopter traffic during pipeline surveys or other activities may result in greater impacts to brant than other types of aircraft traffic. If all of the development in the Goose Molting Area is connected by a road system and individual fields are supplied from staging areas located on coast, it is possible that individual fields could be supplied via the road system and aircraft disturbance could be minimized. However, in that case the level of impact to geese from vehicles would then be increase but would likely be lower than aircraft disturbance. The level of impacts would depend on the final development scenario, the number and location of fields, and whether construction and production activities were conducted primarily with air or road support.

Watercraft. Several types of watercraft could be used during the summer to transport equipment and supplies and to conduct oil spill response training drills. Summer barge traffic (up to 30 barges per year with each CPF requiring 1 or 2 seasons of barge traffic depending on size), with the potential to temporarily displace feeding, molting, brood-rearing and staging waterfowl, could occur in offshore and near shore waters of the planning area from mid-July through October. These impacts would vary depending on the species of birds using the area and activity of those birds at the time of the disturbance but are likely be minor. Displaced waterfowl would probably move to adjacent habitats or return to original habitats after the barges passed though the area, and barge traffic would not be expected to substantially impact

waterfowl. It is well known (Avery, Springer and Dailey 1980) that birds may be attracted to sources of light with the potential for the bird to strike a structure (building, barge, tower etc.) resulting in the possibility of mortality. There are documented accounts of waterfowl and seabirds being attracted to and colliding with ships in various light conditions (Dick and Donaldson 1978). However, there is a short window of time during the fall when the planning area is dark and birds are present, thus the potential for collisions between staging waterfowl and barges working in the planning area is low. There may be a greater likelihood for disturbance to waterfowl under Alternative D as compared to Alternatives A and B, because of the increased potential for development in the Goose Molting Area that may require increased barge support at coastal staging areas. Under Alternative D and Alternatives B, the potential for barge and vessel traffic to disturb birds would be greater than for Alternative A, and less for Alternative C.

Oil spill response training activities using watercraft could be conducted on rivers and lakes several times during the summer. Disturbance from watercraft activity along rivers could affect birds such as ruddy turnstones, semipalmated plovers, and Baird's sandpipers that use gravel bars. The results of disturbance may include failure to nest or nest abandonment (Rodgers and Smith 1995). The potential for these activities to disturb waterfowl and shorebirds under Alternative D would likely be increased compared to Alternatives A and B because there would be a greater likelihood that facilities would be located in areas of high bird use within the Goose Molting Area, and a road system through the area would allow access to goose molting lakes.

Habitat Losses and Alteration

Permanent Habitat Loss. Gravel mining and placement for the construction of oil field infrastructure would have the greatest potential to result in the loss of tundra-nesting bird habitat. Under Alternative D, it is estimated that there will be a need for six central processing facilities (90 acres each) in the planning area. In conjunction with these facilities there are other support structures, such as gravel production pads, gravel runways in-field gravel roads, several types of pipelines, and other associated structures, that will also cause surface disturbances. It is estimated that under Alternative D, there will be: 32 gravel production pads (10 acres each); 6 gravel runways (11 acres each); 320 miles of in-field gravel roads (7.75 acres/mile); 320 miles of three-phase produced fluids (oil, gas, water) gathering lines; 162 miles of sales oil pipelines; 6 pump stations (20 acres each); 3 staging bases (50 acres each); and 14 gravel pits (50 acres each). It is estimated that during the construction phase of these facilities that the total short term disturbance would be 6,765 acres. During the production phase it is estimated that the total long term disturbance would be 4,378 acres (Table 4.2-G).

During the construction of oil field roads and pads, tundra covered by gravel as well as tundra associated with gravel mine sites would be lost as nesting, brood-rearing, and foraging habitat for birds. The potential effects of habitat loss under any alternative would likely have moderate impacts to tundra-nesting birds and would depend on the location of the development, the types of habitat lost, and the level of bird use in the areas to be developed. The impacts of permanent habitat loss on tundra-nesting birds under Alternative D may be reduced compared to Alternative C due to the reduced amount of tundra covered by gravel for facilities under Alternative D. Loss of habitat in areas of high bird use in the Goose Molting Area, however, could cause greater impacts to birds under Alternative D compared to Alternatives A and B. In addition, the potential for roads to be constructed throughout the Goose Molting Area under Alternative D would further increase the potential for habitat loss in areas of high bird use. Birds that use drier habitats may be more affected by habitat loss than those that use wet habitats, because less dry habitat is available in the NPR-A. Loss of dry habitat could be

especially important for buff-breasted sandpiper, which is a species of concern with low population numbers that uses dry habitats. As under Alternative C, there would be an increased potential for birds to be affected by a functional loss of habitat under Alternative D in areas near roads and pads if development-related disturbances precluded birds from utilizing these habitats. The potential for habitat loss to impact tundra-nesting waterfowl and shorebirds would be greater under alternatives B, C, and D as compared to Alternative A.

Temporary Habitat Loss. In addition to permanent habitat loss, modification or temporary loss of tundra habitat adjacent to gravel roads and pads could occur as a result of thermokarst, dust deposition, snow accumulation, and impoundment formation. Water withdrawal from lakes during ice-road construction could temporarily affect birds in adjacent habitats if the lakes did not have adequate recharge capabilities. Under Alternative D, the types of effects to birds resulting from temporary habitat loss would be the same as those discussed under the other alternatives. As with permanent habitat loss, the degree of effects would depend on the location of gravel infrastructure and local use of adjacent habitats by bird populations. Temporary habitat loss under Alternative D could potentially have a reduced impact on tundra-nesting birds, compared to Alternative C, because there is a greater amount of the area unavailable for leasing as well as a greater area covered by of restricted surface occupancy protection than in Alternative C. The potential for locating facilities and a road system in the Goose Molting Area under Alternative D, however, would increase the potential for impacts to birds as compared to Alternatives A and B. The potential for temporary habitat loss to impact birds under Alternatives B C and D would be greater than those under Alternative A.

Mortality

Bird mortality could also result from collisions with structures such as elevated pipelines, buildings, drilling rigs, towers, power lines if suspended, boats (including barges), or bridges. The potential for collisions with oil field structures or equipment is discussed under Alternative A. The magnitude of potential impacts to bird populations as a result of collisions in areas of oil and gas development will depend, among other variables, on the location and type of the structure, the species involved, the lighting regime employed and the weather conditions and would likely impact birds at the level of the individual and not at a population level. Without knowing specific locations of potential developments, it is difficult to compare potential impacts among alternatives. There would be an increased risk of bird collision with offshore barge and vessel traffic under Alternative D as compared to Alternatives A and B due to an increase in barge traffic necessary for transportation of materials for the greater potential of facilities construction in this alternative due to the greater area open to development. There could also be a greater potential for bird collisions with offshore vessel traffic under Alternative D than under Alternatives A and B, given the larger area available for development in the Goose Molting Area under Alternative D, which could increase the potential for development and associated vessel traffic in that area. Under Alternative D, ROP E-10 would require illumination to prevent migrating waterfowl from colliding with drilling structures, production facilities, and other structures exceeding 20 feet in height, although the effectiveness of the stipulation is currently unknown. Although there is no similar lighting requirement under Alternative A, the potential risk of bird collisions with oil field infrastructure could still be greater under Alternative D, because the potential benefits of illumination of facilities may not be adequate to mitigate for the presence of facilities within or near areas of high bird use and the potential for greater development in high density bird areas is higher in Alternative D. Under Alternative D, ROP E-11c requires that power and communication lines be buried in roads or suspended on vertical members, to the extent practical and that support wires be clearly marked along their entire length to improve visibility to low flying birds. Alternative D also requires that studies be

conducted in areas of Yellow-billed loon and endangered species nesting to ensure that facility siting minimizes impacts to birds and by improving visibility of towers, power lines and guy wires in a manner that reduces bird collisions (ROP E-11). Although there is no similar stipulation under Alternative A, the potential risk of bird collisions with oil field infrastructure could still be greater under Alternatives B, C, and D because the potential benefits of illumination of facilities may not be adequate to mitigate for the presence of facilities within or near areas of high bird use. The potential for bird mortality to result from collisions with vessel traffic and oil field facilities and equipment depends on facility location and on the species and numbers of birds in developed areas.

Some predators, such as ravens, gulls, Arctic fox, and bears, could be attracted to areas of human activity where anthropogenic sources of food and denning or nesting sites were present. The potential impacts of increased numbers of predators on birds are discussed under the other alternatives. Increased predation pressure could have moderate impacts on tundra-nesting birds. Under Alternative D, the types of effects to bird populations would be the same as those discussed under the other alternatives. Under Alternative D, there may be the potential for greater bird mortality due to predation than under Alternatives A and B if predators were attracted to development in areas of high bird use that are closed to leasing under Alternatives A and B. Under Alternative C and Alternative D, the potential for bird mortality to result from increased levels of predation would be greater compared to Alternative A. Although all alternatives have ROPs or lease stipulations in place to eliminate attraction of predators to anthropogenic sources of food, the action alternatives would require the lessee to use the best available technology to prevent facilities from providing nesting, denning, or shelter sites for ravens, raptors, or foxes. Still, it may be difficult to totally exclude ravens or foxes from nesting or denning on or in oil field structures. There would be no equivalent lease stipulation under Alternative A.

Effects of Abandonment and Rehabilitation

The impacts of abandonment and rehabilitation of oil fields on birds would be similar in many respects to those incurred by construction activity. Impact types would be the same for Alternative D as described in Alternative A. Alternative D would likely have a greater effect of abandonment and rehabilitation than Alternative A as more area would be available for oil and gas development in Alternative D, potentially resulting greater total area to be abandoned and subsequently rehabilitated.

Effects of abandonment and rehabilitation resulting from Alternative D would likely have less of an impact than effects from Alternative C as more area would be available for leasing in Alternative C. Effects of abandonment and rehabilitation resulting from Alternative D would likely have less of an effect than Alternative B as a greater percentage of Alternative D is unavailable for leasing as compared to Alternative B.

Effects of Spills

Oil spills would have similar types of effects to birds as under the other Alternatives. However, there would be an increased risk of a contaminant spill occurring under Alternative D compared to Alternative A. The potential for an offshore spill would increase because there would be approximately 20% more barge traffic under Alternative D than Alternative A. Offshore spills would have the potential to spread through the action of wind and currents, and could affect molting waterfowl along the coastline or in Harrison and Smith bays, as well as shorebirds feeding in littoral habitats in the Colville River Delta. The risk of an onshore spill risk increases

with increased volume of oil expected to be produced. The risk (or number of) large spills under Alternative D increases by about 27% (0.6 spill – see **section 4.2.2 – Oil Spills)** and the potential spill volume from large spills increases by 2,880 barrels compared to Alternative A.

Under Alternative D, the potential for a terrestrial oil spill in the Goose Molting Area would be greater compared to Alternatives A and B because of the potential to construct facilities and pipelines in the central portion of the Goose Molting Area under Alternative D. A pipeline leak or other spill on terrestrial habitats could affect greater numbers of waterfowl and shorebirds because of the high concentration of nesting and molting birds found in this area. The potential for a terrestrial spill to impact birds under Alternatives B, C and D would be greater compared to Alternative A. The potential for a terrestrial spill to impact birds would be less in Alternative D as compared to Alternative C as there are greater areas of restricted surface occupancy within the goose molting area in Alternative D than in Alternative C.

Oil entering a river or stream could potentially spread into delta or coastal areas, where impacts to birds could be more severe. Waterfowl along the shoreline or in marine habitats and shorebirds in the littoral areas of the planning area could be impacted during the fall molting and staging period. Under Alternative D, the potential that an oil spill would enter a major river or stream would be minimized by the setbacks from goose molting lakes associated with this alternative, although pipelines would not necessarily be prohibited in some of these areas. The other alternatives have lease stipulations with similar levels of protection.

Commercial Gas Development

The types of impacts on birds that natural gas development and production would cause would be the same as those caused by oil development described above, except that there would be no crude-oil spills and, if a gas pipeline is buried, there would be additional acreage disturbed with increased potential for impacts on bird habitat. Any effects on birds of natural gas development and production under Alternative D that are associated with previously constructed oil infrastructure, such as noise and visual disturbance from vehicles or construction activity, are expected to be temporary, nonlethal, and local, affecting a few individuals. As in the case with the other alternatives, resident ptarmigan, gyrfalcons, snowy owls and ravens may be present in the area during construction activities associated with gas development; however, the impacts to these species will be slight, and migrant bird species will not be present during winter construction activities (ADNR, 2006b). Changes in vegetation community caused by burial of the pipeline could result in a loss of bird habitat and would be similar in size to that for Alternatives A and B and about 11% less than that under Alternative C. Any emergency repair of a buried pipeline that occurred in summer has the potential to disturb nesting, brood-rearing, feeding, staging or molting birds. Buried pipelines would not impact birds. Aboveground pipelines could present a collision hazard to low-flying birds.

A natural gas well blowout occurring between May and October could affect birds that are nesting, rearing young, staging, or migrating. Some mortality could result from such an incident, although it is likely that a small number of individuals would be affected. A gas pipeline leak may also cause effects on birds through the presence of response personnel and equipment. Such impacts to waterfowl would be more likely in Alternative D than in Alternative A, because Alternative D would make available for leasing and development the important bird habitat north and east of Teshekpuk Lake. Because this alternative makes less of this habitat available than Alternative C, the risks from a blowout or leak would be less under Alternative D than C.

4.6.8.3 Effectiveness of Stipulations

Numerous lease stipulations and ROPs were developed to protect birds. These include the "A" ROPs, which have been developed to reduce the potential for direct mortality due to oiling, ingestion of toxic materials, or contamination of habitat, prey species, and forage species, and to reduce the attractiveness of industrial sites to predators that could result in elevated predator populations. The "B" ROPs were developed to maintain populations of habitats of fish and invertebrates in order to maintain populations of and habitat for waterfowl.

Lease Stipulation D-1 would prohibit exploratory drilling in lakes, streams, lakebeds, and active floodplains unless impacts to wildlife were minimal. Lease Stipulation D-1 would protect fish-bearing rivers, streams and lakes for blowouts which would help protect bird habitat while Lease Stipulation D-2 would be effective in minimizing surface impacts from exploratory drilling by limiting exploratory drilling to temporary facilities such as ice pads, ice roads, ice airstrips, and temporary platforms, unless the lessee were to demonstrate that construction of permanent facilities was environmentally preferable.

Required Operating Procedure E-1 would be effective in protecting wildlife resources by requiring that all roads be designed, constructed, maintained, and operated to create minimal environmental impacts, while ROPs E-2, E-3and E-4 would protect fish-bearing water bodies which provide food for birds. In addition, ROPs E-8, E-9 and E-10 are designed to protect birds from the impacts of minerals mining activities, human caused increases in predator populations and striking of facilities or other oil and gas infrastructure. ROP E-11 is designed to minimize the take of species listed under the Endangered Species Act and would benefit many bird species. If fully implemented, these ROPs would be effective in reducing, but not eliminating, the impacts of oil development birds. Since many species of birds are sensitive to humans on foot and moving vehicles, there would be some negative effects on their ability to use the area, regardless of how well the field was designed.

Required Operating Procedure F-1(a) would minimize the effects of low-flying aircraft on raptors by requiring an altitude of at least 1,500 feet AGL (except for takeoffs and landings) over raptor nesting sites from April 15 through August 15. ROP F-1(e) requires stipulates that aircraft use over the Goose Molting Area should be minimized from May 20 through August 20 in order to minimize disturbance to nesting and molting waterfowl. Assuming that aircraft operators were aware of the potential effects of aircraft on wildlife and took the appropriate actions to minimize those effects, disturbance impacts to nesting raptors could be effectively reduced.

Lease Stipulations K-4 (general, exploration and development) would require that the operator minimize disturbance to molting geese and loss of goose molting habitat in and around lakes in the Goose Molting Area. These lease stipulations would require restrictions on timing of specific activities, avoidance of goose-feeding habitat types, restrictions on aircraft use during specific periods of time, and the conductance of monitoring studies to determine the consequences of development. Lease Stipulation K-7 pertains to the Colville River Special Area and is designed to prevent loss of raptor foraging habitat by restricting the alteration of high quality foraging habitat within 15 miles of known nest sites.

Lease Stipulation K-11 would delineate the area north of Teshekpuk Lake into seven large lease tracts and limits development to a maximum of 300 acres of permanent surface disturbance resulting from oil and gas development in each tract. This lease stipulation, along with Lease Stipulation K-4(d), would limit the amount of surface disturbance within the area north and

east of Teshekpuk Lake and would help to minimize impacts to waterfowl molting and brood rearing habitats and movements of birds within the area. However, potential impacts would depend on the actual location of any developments within this area.

4.6.8.4 Conclusion

Under Alternative D, the types of disturbances related to vehicle, aircraft, pedestrian, and vessel traffic, routine maintenance activities, heavy equipment use, facility noise, and oil spill clean-up activities would be similar to those described under the other alternatives. Under Alternative D, oil and gas leasing and exploration would be allowed anywhere in the planning area (with a deferral under Teshekpuk Lake), except where lease stipulations prohibit permanent oil and gas facilities in the area north and east of Teshekpuk Lake, southeast/south/southwest of Teshekpuk Lake and in the migration corridors east and northwest of Teshekpuk Lake. In addition, lease stipulations and ROPs would provide seasonal and spatial protection to certain environmentally sensitive areas, including Rivers Area, Deep Water Lakes, Goose Molting Area, Teshekpuk Lake Caribou Habitat Area, Pik Dunes, Colville River Special Area, Coastal Area, and Teshekpuk Lake. The exposure of birds to oil and gas activities, and therefore the level of associated impact, would be greater under Alternative D than under Alternative A, given that leasing of lands adjacent to Teshekpuk Lake could occur and that the overall scale of development would likely be greater under Alternative D. The level of impacts, however, would also be dependant on the location of facilities and development in the Goose Molting Area, which under Alternative D, could increase the effects of development on sensitive species, such as brant. Potential impacts may be greater for brant than for other species due to their apparent inability to habituate to some types of disturbance (Derksen et al. 1992), their decreasing population size, and the potential for as much as 30% of the Pacific flyway population of brant to use the Goose Lake Molting Area. Impacts could be even greater if oil and gas activities occurred in areas with high bird concentrations, with high quality habitat, or used by species of concern. However, exposure of birds to oil and gas activities under this alternative would be less than would occur under alternative C.

The potential for habitat loss and alteration to affect tundra-nesting birds may be greater under Alternative D compared to Alternative C, although the amount of tundra habitat that would be lost to gravel infrastructure would be less. Under Alternative D, there would be a higher potential for infrastructure to be located in areas of high bird use in the Goose Molting Area than in Alternatives A and B. The potential for bird mortality resulting from collisions with vehicles or infrastructure and marine vessel traffic may be greater under Alternative D because of the increased potential for development that may require offshore barge support. The potential for an oil spill to impact tundra-nesting birds would also be greater under Alternative D, as compared to Alternative B, because of the increased potential for an off shore spill from a barge and the potential for a pipeline spill in the Goose Molting Area. The impacts from any alternative would depend on the location and size of the developments and the species and numbers of birds located in developed areas.

It is expected that impacts to birds in the vicinity of Teshekpuk Lake would be greater under Alternative D than under the Alternative A, particularly with respect to goose molting. Overall, impacts throughout the planning area would be greater under Alternative D, given the greater overall scale of the planned development. Impacts associated with Alternative D may be less than Alternative B given the additional Lease Stipulations K-4 exploration and development requirements, and K-11 which help to mitigate many of the potential impacts to birds. Effectiveness of lease stipulations are unknown at this time but are presumed to be effective.

Similarly, impacts to birds under Alternative D would be less than would occur under Alternative C, which has fewer restrictions on the locations of oil and gas activity.

In general, impacts to birds from non-oil and gas activities, and from oil and gas activities, would likely be additive, except in those areas where both types of activities occurred. Impacts to birds from exploration and development activities would also be additive, except where development occurred in areas previously disturbed during exploration. In areas where two or more activities occurred, overall impacts would reflect those impacts associated with the first activity and any new impacts associated with later activities.

4.6.8.5 Potential New Mitigation Measures

The potential mitigation measures for Alternatives B through D are essentially the same as those presented for Alternative A in **section 4.3.8.5.** In Alternative A, they are presented as potential new stipulations, consistent with the approach for protective measures in Alternative A. In Alternatives B through D, they would be considered as potential new ROPs. They are listed below in their ROP form.

1) Colville River Special Area

Potential Mitigation Measure (New ROP)
Objective: Prevent or minimize the loss of nesting habitat for cliff nesting raptors.
Requirement/Standard
a. Removal of sand and/or gravel from cliffs shall be prohibited.
b. Any extraction of sand and/or gravel from an active river or stream channel shall be prohibited unless preceded by a hydrological study that indicates no potential impact by the action to the integrity of the river bluffs.

Potential Benefits and Residual/Unavoidable Impacts

Prohibiting the removal of sand and gravel from cliffs in the Colville River Special Area will enhance existing protections to raptor nest sites in this Special Area. Preservation of cliffs would allow for the continued expansion of the breeding population of cliff nesting raptors in the Colville River Special Area by providing potential nest sites for all species of cliff nesting raptors. Prohibition of removal of sand and/or gravel from an active river or stream channel will negate to potential for subsequent erosion of downstream cliffs. Nest sites for cliff nesting raptors are potentially population limiting and destruction of cliff nest sites caused by sand/gravel mining would accelerate the existing natural erosion of cliffs in the Special Area.

Paleontological resources may indirectly benefit from this measure by providing protection to the substrates that may contain these undiscovered resources. Water quality downstream of a gravel mining operation that occurs in the river bed would benefit from the prohibition of mining in the stream bed and the subsequent erosion of downstream cliffs. Visual resources and recreation would benefit from this measure by virtue of an environment unchanged by human cause gravel mining and subsequent erosion of downstream cliffs.

Construction costs may increase in some situations if gravel needs to be transported to the construction site instead of mining of gravel near the site.

2) Raptor Protection

Potential Mitigation Measure (New ROP)
Objective: Prevent or minimize the loss of raptors due to electrocution by power lines.
Requirement/Standard
Comply with the most up to date suggested practices for raptor protection on power lines. Refer to the publication: Suggested Practices for Avian Protection on Power Lines: The State of the Art in 2006 Item #40-06-01-008 funded and produced by the Avian Power Line Interaction Committee and the California Energy Commission.

Potential Benefits and Residual/Unavoidable Impacts

Requiring all power lines and poles to be designed and constructed in a manner which reflect raptor safe configurations will prevent death of raptors by electrocution.

Additional cost may be incurred by the developer in order to provide raptor safe power lines and poles.

4.6.9 Mammals

4.6.9-a Terrestrial Mammals

4.6.9-a.1 Activities Not Associated With Oil and Gas Exploration and Development

The types of impacts to terrestrial mammals under Alternative D would be similar to those that would occur under the other alternatives, but could be more frequent, greater in extent, or longer in duration than those occurring under Alternative A. A greater number of individual animals would be exposed to human activities. Aircraft traffic would more often pass over caribou and other terrestrial mammals during flights to or from the camps and along aerial survey routes. The disturbance reactions of caribou and other terrestrial mammals would likely be brief, lasting for a few minutes to an hour. Some terrestrial mammals might avoid inventory survey and recreation camps during the 6 to 12 weeks of activities, while bears and foxes could be attracted to the camps. Impacts from recreation and overland moves would be the same as under Alternative A. Proposed lease stipulations and ROPs addressing land use authorizations for temporary facilities, overland moves, and recreation permits would effectively mitigate impacts from these activities on terrestrial mammals.

4.6.9-a.2 Oil and Gas Exploration and Development Activities

Under Alternative D, oil and gas leasing and exploration would be allowed throughout the planning area (with a deferral for Teshekpuk Lake), but lease stipulations would limit surface occupancy in the Goose Molting Area northeast of Teshekpuk Lake (approximately 240,000 acres), in the caribou calving area southeast and southwest of Teshekpuk Lake (approximately 233,000 acres), and in the caribou movement corridor between Teshekpuk Lake and the Kogru River (approximately 45,000 acres) (Figure 2-4). In addition, lease stipulations would provide seasonal and spatial protection to certain environmentally sensitive areas, including Rivers Area, Deep Water Lakes, Goose Molting Area, Teshekpuk Lake Caribou Habitat Area, Pik Dunes, Colville River Special Area, Coastal Area, and Teshekpuk Lake. The exposure of terrestrial mammals to oil and gas activities, and therefore the level of associated impact, would

be greater under Alternative D than under Alternative A, given that leasing of lands adjacent to Teshekpuk Lake could occur and the overall scale of development would likely be greater under Alternative D. Exposure of terrestrial mammals to oil and gas activities under Alternative D would likely be reduced compared to alternatives B and C because of the additional lease stipulations provided under this alternative.

Effects of Disturbances

Seismic

Impacts to terrestrial mammals would be nearly the same as those discussed under the other alternatives since it is assumed that the extent of terrestrial seismic operations would be the same under all alternatives. The only change is that seismic surveys on Teshekpuk Lake are considered less likely under Alternative D than in Alternatives B or C. It is expected that the reactions of caribou and other terrestrial mammals to disturbance would be brief, although large numbers of wintering TLH caribou would likely be encountered, depending on the location of exploration activities (see Alternative A for a description of potential adverse impacts). Some caribou and other large mammals would likely be displaced from the general area of the seismic work. Some terrestrial mammals would avoid seismic camps, while others, such as foxes, could be attracted to the camps by food odors. The potential for disturbance to hibernating bears would remain, but bears are only present at low densities in the planning area. Muskox and moose would most likely be present in their greatest numbers in the southern portion of the planning area.

The use of airguns for seismic work in Teshekpuk Lake during the summer would likely cause only temporary displacement of terrestrial mammals near the lake. Displacement would occur primarily from the support activity associated with the surveys, such as helicopter flights to bring equipment to the lake. Once surveys were finished and the sources of disturbance had been removed, mammals would likely move back into the area around the lake. However, Teshekpuk Lake would be deferred from leasing under Alternative D, which would likely limit seismic activity in the lake.

Exploratory Drilling

Under Alternative D, it is projected that the number of exploration and delineation wells drilled (193) would be greater than for Alternative A and Alternatives B, but less than for Alternative C. Types of impacts to terrestrial mammals would be similar to those discussed under Alternative A, but greater in spatial extent, frequency and magnitude, as more exploration would occur, particularly in the area to the northwest, south, and east of Teshekpuk Lake, which would be excluded from leasing under Alternative A. Exploratory drilling would be conducted during the winter, when some mammal species are less active or less often present, although wintering TLH caribou could be present in large numbers. Exploratory drilling could also occur from pads and platforms in lakes in the TLCH Area during summer, potentially disturbing mammals found near this activity. Moose, muskox, and grizzly bears would experience a greater level of impacts than under Alternative A.

The implementation of lease stipulations and ROPs would minimize impacts to terrestrial mammals. These lease stipulations and ROPs would include provisions to avoid known grizzly bear dens by ½ mile, methods to avoid attracting wildlife to food and garbage, provisions to protect stream banks from damage during overland moves, provisions to minimize the effect of

low-lying aircraft on wildlife (particularly over caribou winter ranges), and provisions to minimize the disturbance and hindrance of caribou in the TLCH Area.

Oil Development

Approximately 95% of the planning area would be made available for leasing under Alternative D. Leasing would be allowed throughout the planning area. However, additional lease stipulations would limit development in the approximately 240,000-acre region northeast of Teshekpuk Lake and would protect the caribou calving area south and southeast of Teshekpuk Lake (approximately 233,000 acres), and the caribou travel corridor between Teshekpuk Lake and the Kogru River (approximately 45,000 acres) by creating RSO areas.

The primary effects of oil and gas development on terrestrial mammals would be similar to those outlined under the Alternative A, and would result from construction of facilities such as roads and pipelines; motor vehicle traffic within the oil field(s) and on connecting roads; foot traffic near facilities and camps; aircraft traffic; crude-oil and fuel spills contaminating tundra, stream, and coastal habitats; and habitat alteration associated with gravel mining and construction. These impacts would likely be greater under Alternative D than under Alternatives A and B, given the larger development scenario that would affect approximately 958 and 612 additional acres, respectively, of habitat under long-term disturbance as compared to Alternatives A and B, and the availability for lease of the high potential lands in the northern portion of the planning area. Alternative D would affect 171 acres less than Alternative C. In all alternatives, functional loss of habitat would be greater than the number of acres indicated, which is the actual development footprint. Wolfe (2000) suggested that when caribou in the CAH avoided areas within 2.5 miles of roads and pipelines, the functional habitat loss increased from 2% (the immediate footprint of roads and gravel pads) to 29%.

Construction of permanent roads within the planning area could increase access to the area and could increase public and subsistence hunting of terrestrial mammals if those roads were to connect to villages or the larger road system. Among ungulate species, caribou would be most impacted by increased access for hunting, but other species (moose in particular) may also be impacted depending on the location of permanent roads. The overall number of animals taken would be unlikely to increase dramatically since most hunting would be for subsistence, but roads could focus hunts in particular portions of the planning area. Hunting pressure and harvests have increased for many wildlife species near the TAPS since its construction, but have not produced adverse population effects (TAPSO 2001). It is unlikely that the more remote roads associated with oil and gas development in the planning area would have as great an effect on wildlife populations as occurred along the TAPS corridor.

<u>Caribou</u>

Although much of the construction associated with oil and gas development would occur primarily during winter, development would bring year-round facilities and activities to caribou range. If a field were developed in the area surrounding Teshekpuk Lake, production pads, pipelines, within-field roads, and other facilities would be located within areas used by the TLH caribou for calving, insect relief, and wintering. A field development in the northern section of the planning area would also require a connector pipeline to link the oil field with facilities to the east.

The types of impacts of field development on caribou would be similar to those outlined under Alternative A. However, given the greater possibility that a field would be developed within the calving, insect-relief, and wintering grounds of the TLH caribou, impacts to caribou could be

greater under Alternative D than under Alternative A or B, but somewhat less than for Alternative C because of the greater restrictions on surface development in Alternative D compared to C. Overall, the level of impact would be dependent on the specific location of any oil field—a field in the central or southern portion of the planning area would not impact the TLH caribou calving grounds, although such a development could still affect migratory movements of TLH and WAH caribou as well as activities on their wintering ground.

Development in the TLH caribou calving grounds could displace some calving animals within 2½ miles of roads. Movements of some cows and calves across roads would also likely be reduced, and cow caribou might avoid crossing the roads during the calving season. Lease Stipulation K-11 would limit development north of Teshekpuk Lake and would help protect caribou calving areas in that region. Additionally, Lease Stipulation K-10 creates an RSO area southeast and southwest of Teshekpuk Lake (233,000 acres). This area in addition to the areas north of Teshekpuk Lake is important to caribou calving. These lease stipulations prohibit permanent oil and gas facilities excluding major rights-of-ways for pipelines within these areas. Lease Stipulation K-11 would delineate the area north of Teshekpuk Lake into seven large lease tracts and limits development to a maximum of 300 acres of permanent surface disturbance resulting from oil and gas development in each tract.

Some TLH caribou movements during the insect-relief season (late June to mid-August) would likely be affected by pipelines and road traffic. A critical part of the movement to the coastal insect-relief area is through the narrow corridor between Teshekpuk Lake and the Kogru River. Caribou must pass through these corridors to get to and from insect-relief areas. The areas to the east and the northwest of Teshekpuk Lake are particular problems, because nearly all of the parturient cows pass through these areas either shortly before or after calving (Person et al. in press). Any development that occurs on the limited amount of habitat that is used by caribou migrating through these corridors would likely affect caribou movements. Lease Stipulation K-9 designates an RSO area extending from the eastern shore of Teshekpuk Lake approximately 4 miles eastward towards the Kogru Inlet (approximately 45,000 acres). The RSO designation prohibits permanent oil and gas facilities including roads, but excluding pipelines. This lease stipulation is intended to protect enough land to allow caribou use of this major migration corridor. Careful siting of pipeline rights-of-way would still be required to minimize adverse affects on caribou use of this corridor. Additionally, the areas that would be excluded from surface occupancy do not extend to the coast in much of the area, suggesting that there could be some development along the coastline. While a ¾ mile set-back from the coast is stipulated (Lease Stipulation K-6), development in the coastal area could still impact caribou use of insect-relief areas near the coast, though the number of developments would be restricted by Lease Stipulation K-11.

Traffic associated with hauling gravel from outside of the planning area could result in local disturbance and displacement of caribou within one to a few miles of the operations. A pipeline linking oil fields in the planning area with facilities at the Alpine and Kuparuk River fields would result in the disturbance and displacement of some caribou during winter construction, due to vehicle traffic along ice roads and air traffic. It is expected that these disturbances would be short term (but see Alternative A's discussion of potential effects of seismic operations) and occur within about one to a few miles of the pipeline corridor.

<u>Moose</u>
Moose occur in low densities in the planning area during the summer, and are concentrated in major drainages at the southern edge of the planning area in the winter (Map 3-26). Unless an oil field were to be developed in the southern portion of the planning area, development would

be unlikely to impact moose. Under Alternative D, impacts to moose would be similar to those discussed under the other alternatives, although they could be greater in duration and area than under Alternatives A and B, given the larger overall development scenario under Alternative D. Conversely, they may be lesser in duration and area than under Alternative C.

If gravel were mined from the southern portion of the planning area, a temporary displacement and disturbance of moose could occur. Borrow pit operations could potentially destroy or degrade 20 to 50 acres of moose habitat per borrow pit if gravel borrow operations occur in the southern portion of the planning area.

Muskox

Muskoxen occur in low densities in the planning area, and they may not be present year-round in all years. Potential effects of oil and gas development activities include displacement and disturbance of individual animals, direct habitat loss from gravel mining in river floodplains and placement of gravel at oil field facilities, and indirect habitat loss through reduced access caused by physical or behavioral barriers created by roads, pipelines, and other facilities. Under Alternative D, impacts would be similar to those under the other alternatives, although they could be greater in duration and area than under Alternatives A and B, given the larger overall development scenario. Conversely, they may be lesser in duration and area than under Alternative C. Impacts would be greatest if development were to occur in the southern portion of the planning area.

Grizzly Bears

Major sources of noise include construction of roads, installation of crude oil pipelines, pump stations, gravel mining, and drilling operations. These activities could disturb grizzly bears within a few miles of the noise sources. Industrial activities and human presence could also cause potentially serious disturbances to denning bears. Under Alternative D, impacts to grizzly bears would be similar to those that would occur under the other alternatives, although the extent and duration of impacts could be greater than under Alternatives A and B because of the larger overall development scenario, depending on the location of the field development. Conversely, they may be lesser in duration and area than under Alternative C. Grizzly bears are present at low densities in the northern portion of the planning area, but could be attracted to some activities. It is likely that the greatest number of bears would be encountered during development activities in the southern portion of the planning area, since the greatest amount of suitable habitat is located in this area.

Wolves

Under the Alternative D, oil and gas development would have a minimal impact on wolves, similar to the other alternatives. Potential effects to wolves would include short-term disturbance from air and surface traffic and human presence, and increased hunting and trapping pressure through improved access or increased human presence associated with oil development. If caribou abundance were negatively affected by oil and gas development, wolf abundance could in turn be affected. However, wolves are generally not abundant in the planning area.

Wolverines

The potential effects of oil and gas development on wolverines under Alternative D are the same as under other alternatives and could include disturbance from air and surface vehicle traffic, increased human presence, and habitat alteration. Documented sightings and harvest locations suggest that wolverines could be encountered along rivers and in the vicinity of Teshekpuk Lake. Under Alternative D, some wolverines could be displaced in the vicinity of oil field

facilities. Impacts under this alternative are likely to be similar to, or slightly greater than, those that would occur under Alternatives A and B, given the larger overall development scenario. Conversely, they may be less than under Alternative C.

Foxes
Under Alternative D, impacts to foxes would be similar to those under the other alternatives, although they could be greater in duration and extent than under Alternatives A and B, but less than under Alternative C. Oil and gas development activities could affect foxes by increasing the availability of food and shelter. An increase in the fox population associated with oil development could affect some fox-prey species (such as ground-nesting birds and molting waterfowl) in the development area and over a region larger than the oil field itself (Burgess et al. 1993).

Other Mammals
Small rodents and their predators would be affected locally (i.e., through direct mortality of individuals or small groups of lemmings and voles, or through loss of habitat) along pipelines, gravel pads, and other facilities. Arctic ground squirrels sometimes den in gravel fill in the oil fields (Shideler and Hechtel 2000). The availability of suitable burrowing habitat could increase local densities of ground squirrels. Under Alternative D, impacts to small mammals would be slightly greater than those that would occur under Alternatives A and B, given the larger overall scale of the development scenario. Conversely, they may be less than under Alternative C.

Effects of Abandonment and Rehabilitation

Abandonment and rehabilitation activities are expected to disturb and displace terrestrial mammals in a manner similar to that associated with construction. The intensity of the disturbance might be less than during construction, however, because it is possible that caribou, muskoxen, and other terrestrial mammals would have become habituated to road and air traffic over the course of construction and operation of the facilities. Some individuals could be killed by collisions with road traffic. If roads were left in place and maintained in useable condition upon abandonment, they could continue to provide improved access to hunting areas, with consequent hunting pressure on caribou and other subsistence species. Revegetation of the roads, pads, and the airstrip left in place would facilitate rehabilitation of habitat, but plant communities on these raised gravel structures would likely be different from those that prevail in adjacent areas and may include invasive species. Pads, roads, and the airstrip could provide some insect-relief habitat for caribou, if left in place (Murphy and Lawhead 2000). If gravel fill was removed and the pad revegetated with vegetation similar to the surrounding plant communities, caribou, and possibly other terrestrial mammals, would use the area. Foam insulating materials that could be used in pad construction could be broken up in the course of removal. If some of this foam escapes being cleaned up, it may be used by foxes as denning material. Depending on the material's toxicity and the amount ingested by a fox, this could cause mortality, though the numbers of fox killed would likely be very small. Overall, a greater amount of development is assumed under Alternative D than under Alternatives A or B, providing a potential of greater impacts from abandonment and rehabilitation. However, they would likely be expressed over a longer time period resulting in no population level effects from these activities in either case. The converse may be expected under Alternative C.

Effects of Spills

Typical refined products that are spilled on the Alaska North Slope include aviation fuel, diesel fuel, engine oil, fuel oil, gasoline, grease, hydraulic oil, transformer oil, and transmission oil. The extent of environmental impacts would depend upon the type and amount of material spilled, the location of the spill, and the effectiveness of the response. The majority of small spills would be contained on the gravel pad and would have no impact on terrestrial mammals or their habitat.

The impacts of oil spills on terrestrial mammals are described under Alternative A (**section 4.3.9, *Mammals***). Compared to Alternatives A and B, the risk of oil spills would be greater, but still small, under Alternative D, given the greater extent of development and the increased estimated number of spills. Conversely, they may be less than under Alternative C. Activities occurring in the vicinity of Teshekpuk Lake could increase the likelihood that a spill would reach the lake under Alternative D than under Alternative A. This probability would be less than under Alternative C, but not substantially different than under Alternative B. Because most spills would be small and affect a small area, the majority of impacts to terrestrial mammals would likely result from disturbance associated with spill clean-up activities rather than direct oiling.

Commercial Gas Development

The types of impacts from gas development under Alternative D would be similar to that for Alternative B, greater than for Alternative A (because more important caribou habitat would be made available for lease and development), and less than Alternative C (because less gas pipeline is projected and less of the important caribou habitat is made available for lease and development). Buried pipelines would have no impact on caribou movement, though disturbance could occur during winter construction in approximately the same way as it would occur by construction of aboveground pipeline. The noise associated with a 10- to 20-acre compressor station may cause avoidance, but the pad's raised surface may attract caribou seeking insect relief.

If a gas pipeline was elevated on a set of VSMs separate from oil-pipeline bearing VSMs, caribou movement could be hindered.

Construction and operation of gas facilities would likely impact other terrestrial mammals in a manner similar to and in like proportion, when comparing among alternatives, to the impacts associated with oil development.

In the event of a natural gas well blowout or pipeline rupture, would be similar to that described for the other alternatives. Terrestrial mammals in the immediate vicinity of the blowout could be killed. Given the small area that would be exposed to the plume and the rapid dissipation of the gas, it is not likely that any animals other than individuals present in the immediate vicinity at the time of the blowout would be affected. The likelihood of caribou, moose, muskoxen, wolves, or grizzly bears being exposed to toxic amounts of gas and condensates is very low and (should it occur) would probably only affect a few individuals. Smaller, less mobile species with small home ranges, such as squirrels, voles, and lemmings may be affected in larger numbers. However, there would be no population level impacts on any species.

4.6.9-a.3 Effectiveness of Stipulations

Alternative D would include almost the same lease stipulations and ROPs that were outlined under Alternative B. (**section 4.4.9.1, *Terrestrial Mammals***), and they would provide similar protection to terrestrial mammals as those developed for Alternative B.

Additional lease stipulations associated with Alternative D also provide protection for terrestrial mammals. Lease Stipulation K-4(d) creates an RSO in the Goose Molting Area north and east of Teshekpuk Lake (approximately 240,000 acres). This lease stipulation would provide protection for caribou calving and insect-relief areas located in this region and should effectively limit impacts to caribou associated with development.

Lease Stipulation K-9 would designate an RSO area extending from the eastern shore of Teshekpuk Lake approximately 4 miles eastward towards the Kogru Inlet (approximately 45,000 acres) and another northwest of the lake (approximately 9,700 acres). The RSO designation prohibits permanent oil and gas facilities with the exception of a pipeline. This lease stipulation is intended to protect enough land to allow caribou use of this major migration corridor.

Lease Stipulation K-11 would delineate the area north of Teshekpuk Lake into seven large lease tracts and limits development to a maximum of 300 acres of permanent surface disturbance resulting from oil and gas development in each tract. This lease stipulation, along with Lease Stipulation K-4(d), would limit the amount of surface disturbance within the area north and east of Teshekpuk Lake and would help to minimize impacts to caribou calving and insect relief habitat and movements of caribou within the area. However, potential impacts would depend on the actual location of any developments within this area.

4.6.9-a.4 Conclusion

Under Alternative D, impacts to terrestrial mammals would be similar to those discussed under the other alternatives, but would be greater in frequency and extent than for Alternatives A and B because of the high oil and gas potential of the northern portion of the planning area, and the potential for greater development to occur, including in areas currently off-limits to surface development activities.

Under Alternative D, oil and gas leasing and exploration would be allowed anywhere in the planning area (with a deferral under Teshekpuk Lake), but lease stipulations prohibit most permanent oil and gas facilities in the area north and east of Teshekpuk Lake, southeast/south/southwest of Teshekpuk Lake and in the migration corridors east and northwest of Teshekpuk Lake. In addition, lease stipulations and ROPs would provide seasonal and spatial protection to certain environmentally sensitive areas, including Rivers Area, Deep Water Lakes, Goose Molting Area, Teshekpuk Lake Caribou Habitat Area, Pik Dunes, Colville River Special Area, Coastal Area, and Teshekpuk Lake. The exposure of terrestrial mammals to oil and gas activities, and therefore the level of associated impact, would be greater under Alternative D than under Alternatives A and B, given that leasing of lands adjacent to Teshekpuk Lake could occur (as opposed to Alternative A) and that the overall scale of development would likely be greater under Alternative D. However, exposure of terrestrial mammals to oil and gas activities under this alternative would be less than would occur under alternative C.

It is expected that impacts to terrestrial mammals throughout the planning area, and especially in the vicinity of Teshekpuk Lake, would be greater under Alternative D than under Alternative A or B, particularly with respect to caribou calving and insect-relief habitat. They would be less, however, than for Alternative C. Impacts associated with Alternative D may be less than Alternative B given the additional Lease Stipulations K-4(d), K-9, K-10, and K-11 which help to mitigate many of the potential impacts to caribou. Similarly, impacts to terrestrial mammals under Alternative D would be less than would occur under Alternative C, which has fewer restrictions on the locations of oil and gas activity.

In general, impacts to mammals from non-oil and gas activities, and from oil and gas activities, would likely be additive, except possibly in those areas where both types of activities occurred. Impacts to mammals from exploration and development activities would also be additive, except possibly for habitat impacts where development occurred in habitats previously disturbed during exploration. In areas where two or more activities occurred, overall impacts would reflect those impacts associated with the first activity and any new impacts associated with later activities. Based on the amount of habitat with a potential to be affected, the potential for impacts to mammals under this alternative would be about 37% more than Alternative A. If oil and gas activities occurred in areas with an abundance of caribou or other mammals, or in areas with high quality habitat, impacts could be greater than those based strictly on number of acres of habitat impacted.

4.6.9-b Marine Mammals

4.6.9-b.1 Activities Not Associated With Oil and Gas Exploration and Development

Alternative D is expected to have impacts associated with non-oil and gas activities similar to those described for the previous Alternatives. These activities could occur throughout the planning area and would not be affected by the increased availability of land for oil and gas leasing.

Overland moves could disturb a few ringed seals if overland moves were to occur over floating, shore-fast ice. It is expected that small fuel spills would occur under Alternative D. It is expected that small fuel spills would occur, but they would be small, and primarily terrestrial and unlikely to reach areas used by marine mammals.

Under Alternative D, it is expected that the effects of non-oil and gas activities on marine mammals would be localized and short term, with no or minor effects to marine mammal populations.

4.6.9-b.2 Oil and Gas Exploration and Development Activities

Effects of Disturbances

The frequency, spatial extent, and magnitude (intensity and duration) of the impacts likely will vary among alternatives in relation to the total amount of area open to development, the location of the areas open, and the Lease Stipulation and Required Operating Procedures. The potential for impacts is expected to be proportional to the differences in area impacted and vessel trip estimates. Alternative D makes approximately 95% of the planning area open to exploration and development. The Alternative D development scenario estimates approximately 25% (1,110 acres) more permanent surface disturbance than Alternative A; 15% (660 acres)

more permanent disturbance than Alternative B; and 6% (271 acres) less permanent disturbance than Alternative C. With regards to marine mammals it is primarily the level of indirect effects associated with development D–primarily vessel traffic–under Alternative D that separates its impact potential from the other Alternatives. Like Alternatives B and C, opening the area north of Teshekpuk Lake creates a greater potential for adverse impacts to marine mammals compared to Alternative A although special restrictions under Lease Stipulation K-4 still apply within ¾ mile from the coast line.

Seismic

Seismic exploration is expected to have the same potential for affect and likelihood to occur as under the other Alternatives. However, the ¾ mile coastal buffer required by ROP K-4 would reduce the attractiveness of the Atigaru/Kogru area making the likelihood of seismic in these areas lower than under Alternative A. The low likelihood of seismic under this alternative combined with the expected very low density of seals in these shallow areas (Moulton et al. 2005) makes it unlikely that seals would be affected by seismic work. No affect to whales is anticipated.

Visual and Noise Disturbance

Aircraft

The effects of aircraft disturbance would be similar to those described under the previous Alternatives, but could be greater in extent than under A and B given the greater number of pads and production facilities expected under Alternative D, but less than under Alternative D. More importantly, because more development area for development would be open north of Teshekpuk Lake the number of aircraft that would regularly occur over areas that may be used by marine mammals would be greater compare to Alternative A and B. However aircraft would generally fly at 1,000 feet AGL over water due to Lease Stipulations to protect caribou and molting geese, minimizing the potential for disturbance to seals and most likely whales (Born et al. 1999, Patenaude et al. 2002, Richardson and Williams 2004, Moulton et al. 2005).

Shipping

It is expected that the difference in impacts from shipping among alternatives is proportional to the difference in number of vessel trips. Six to 12 sealifts would are estimated to be necessary support development of the estimated 6 CPFs under Alternative D; totaling 180 to 360 barges (approximately 20% more than estimated for Alternative A, 20% less than under Alternative D and the same as Alternative B). In addition, it is possible that barges could be landed on the northern coast of the planning area, most likely at Lonely. In this scenario, increased barge traffic during the summer could result in more disturbance and displacement of whales and seals than under Alternative A because barges would be maneuvering off the coast and be in place for several days instead of transiting past. Although like Alternative A and B the displacement/disturbance is expected to be localized in time (only occur within a short distance <1 mile for seals, 1-4 miles for whales) in time and short-term (hours or days) It is not expected that effects would levels that could result in substantial impacts to individual marine mammals or populations, although the fitness of some individuals could be impacted.

Contaminants

The effects of a spill on marine mammals would be as described under the Alternative A. The likelihood of a spill reaching or occurring in areas used by marine mammals is higher due to the greater amount of development but is still very low with little difference in potential between alternatives. Although a greater amount of coastline in the planning area is open than under Alternative A, Lease Stipulation K-4 places a ¾ mile buffer along the entire coastline, including the area around Atigaru Point, which is open under Alternative A.

Collisions

The likelihood of a vessel strike is influenced by the number of vessels traveling through an area over time. Speed probably has an influence on the likelihood of a collision and does increase the potential that a collision will result in sever injury or death (Laist et al. 2001). Alternative D would result in similar levels of vessel traffic to Alternative B and there would be an increase in risk compared to Alternative A with a commiserate decrease in the likelihood of a collision compared to Alternative C. Given the expected low rates of collisions (George et al. 1994), this change while moderate in percentage terms is likely a minor risk in actual number of animals injured or killed.

Effects of Abandonment and Rehabilitation

The potential for impacts and type of impact resulting from abandonment and rehabilitation activities are expected to be similar to those for construction under this Alternative. Given the expense of transport, vessel traffic is expected to be substantially lower than occurred during construction as large modules or other equipment may be moved to other development or stored at regional staging areas rather than moving it off the North Slope. The potential for impacts is expected to be proportionally higher compared to Alternative A, similar to Alternative B, and less than Alternative D.

4.6.9-b.3 Effectiveness of Stipulations and Required Operating Procedures

Alternative D includes the same lease stipulations and ROPs as outlined under alternatives B and C and some additional stipulations to protect caribou and molting geese. These ROPs and lease stipulations should provide similar levels of protection as those developed for the Alternative A. The additional lease stipulations included in Alternative D would have little effect on impacts to marine mammals.

4.6.9-b.4 Conclusion

Under Alternative D, the effects of non-oil and gas activities on marine mammals, particularly ringed seals along the coast of the planning area, would be short term and localized, occurring within one mile of aircraft corridors, survey activities, recreational camps, and overland moves.

The difference between impact potential of each alternative on marine mammals is primarily a factor of how much area is available for development and the projected amount of oil produced. No alteration of marine habitat is anticipated under any of the alternatives so the projected impacts are related to the difference in disturbance potential between Alternatives and the likelihood of a spill or collision. In this respect Alternative B and D have similar potentials for adverse effects on marine mammals, while Alternative A has less, and Alternative C has slightly more.

Oil and gas leasing and development activities would likely result in a greater level of noise and disturbance, primarily near the Colville River Delta and inner Harrison Bay, than under the other alternatives because of the greater level of development. Effects should be localized (within one mile of aircraft corridors and activities) and short term as individual sealifts would typically be completed in one season. Lease Stipulation K-6 would minimize the potential for development to impact ringed seals, spotted seals, and beluga whales in areas along the coast. While exploration could occur in this area under Alternative C, surface occupancy would generally not be allowed. The effects of seismic exploration would be limited to short-term, localized disturbance to denning or hauled out ringed seals. The effects of development under Alternative C are expected to be short term, with few effects on marine mammal populations.

A small number of ringed seals, spotted seals, beluga whales, and possibly harbour porpoise could be affected by oil spills entering the Kogru River, the Colville River, or drainages that empty into the Colville River, Fish Creek, or Judy Creek. The likelihood of such and event is small and not expected to occur. It is expected that any losses would be small.

The effects of development under Alternative C are expected to be greater than those under the Alternative A and B due to the greater amount of exploration and development projected to occur under this alternative. However, these effects would be short term, with few impacts on marine mammals and no detectable impact on populations. Since nearly all exploration and development activity would occur onshore under all alternatives, the potential for impacts to marine mammal resources under Alternative D would be slightly greater than those that could occur under the Alternative B and greater than those under Alternative A, but less than Alternative C.

4.6.10 Threatened and Endangered Species

This section discusses the potential effects to bowhead whale, spectacled and Steller's eiders, and polar bear which could result from management action in the planning area under Alternative D. Whales would be most affected by disturbance and oil spills. Most, but not all, activities that could potentially affect eiders and polar bears in the planning area would be associated with oil and gas exploration and development. Other activities that could occur in the planning area include subsistence hunting, recreational use, and activities associated with scientific survey and research camps.

4.6.10-a Bowhead Whale

4.6.10-a.1 Activities Not Associated With Oil and Gas Exploration and Development

Under Alternative D, the effects of non-oil and gas activities on bowhead whale would be similar to those that would occur under Alternative A, and would occur only when bowhead whales migrated exceptionally close to shore. It is not expected that non-oil and gas activities would have high impacts on individual bowhead whales or the population.

4.6.10-a.2 Oil and Gas Exploration and Development Activities

Effects of Disturbances

The effects of oil and gas activities on bowhead whales would likely be greater under Alternative D than under Alternative A, given the greater area available for development. Alternative D opens up to 300 acres in each of seven lease blocks north of Teshekpuk Lake for development, including areas near the coast. If developments up to 300 acres in size were placed near the coast (although Lease Stipulation K-6 would require that permanent facilities be sited at least ¾ of a mile from the coastline to the extent practicable), then effects to bowhead whales could be as great as those possible under Alternative C. Vessel activity in Harrison Bay and other areas off the coast of the planning area could increase under Alternative D when compared to Alternative A; be similar to Alternative B, but would not be expected to increase to the same extent as under Alternative C. An increase in barge traffic by approximately 20% (compared to Alternative A) along the coast to transport equipment and supplies for development within the planning area, and a potential increase in activity at staging areas along the coast, would increase the potential for impacts to migrating bowhead whales. There is also a greater likelihood that aircraft operation over marine waters would increase under Alternative D compared to Alternative A. Effects to bowhead whales would be expected if bowhead whales migration close to shore. As discussed under Alternative A the effects of those activities are expected to be limited to short term avoidance behavior, but more studies are required to assess the consequences of eliciting this behavior. It is unknown if the potential increase in these disturbance activities will result in an impact level that significantly reduces the fitness of individual bowhead whales, although it is unlikely that population level effects would be detected.

Contaminants

There would be a greater potential for oil spills under Alternative D than under Alternative A, given the larger area available for development and higher levels of development activity that would occur under Alternative D. Risk would be similar as under Alternative B, and less than under Alternative C. It is unlikely under any alternative that a spill large enough to reach bowhead whale habitat would occur, unless development is allowed to occur along the coast. The potential for an accidental release from barge traffic would increase compared to Alternative A due to the estimated increase in number of barges but this remains an unlikely event (although the probability of a spill occurring would increase relative to Alternative A, decrease compared to Alternative C, and be similar to Alternative B as a result of 20% more barge traffic).

The southward edge of the migration corridor could be deflected northward due to any vessel activity associated with containment and clean-up activities occurring during the fall migration. However, impacts to individual bowhead whales or the whale population would be minor, except in the case of a very large spill coincident with the fall migration, which is very unlikely.

Collisions

Alternative D, like Alternative B is estimated to result in an approximate 20% increase in barge traffic over Alternative A. The projected increase in barge traffic would not all occur in one year but would consist of more sealifts than Alternative A spread over some period of time, likely separated by 5 to 10 years and likely over a longer period of total time than Alternative A. The likelihood of a vessel strike is influenced by the number of vessels traveling through an area

over time thus the likelihood of a collision is increased under Alternative D compared to Alternative A and decreased compared to Alternative C. However, given the expected low rates of collisions observed in the past (George et al. 1994), those expected based on the low rate of speed barges typically travel (Laist et al. 2001), and that barges usually are active only during the earlier portion of migration, this change, while moderate in percentage terms is likely a minor risk in actual number of whales injured or killed.

Effects of Abandonment and Rehabilitation

Impacts of abandonment and rehabilitation activities are expected to be similar to those for construction and higher than under Alternative A, slightly higher than Alternative B, and slightly lower than under Alternative C. Effects could occur from aircraft, barges used to transport equipment to remove materials from the planning area, and potential spills.

Commercial Gas Development

If natural gas development and production occur in the planning area, it is unlikely that bowhead whales would be affected other than temporary, nonlethal effects from marine vessels as described for traffic associated with oil development.

4.6.10-a.3 Effectiveness of Stipulations and Required Operating Procedures

There are no Stipulations or Required Operating Procedures specific to bowhead whales, but several would indirectly reduce the potential that any oil spill would reach marine waters. Lease stipulation K-1 requires no development setbacks from the banks of major rivers in the planning area. While this stipulation does not prohibit pipelines from crossing rivers, development would be prohibited from within ½ to 3 miles from the banks. This should substantially reduce the potential for a large spill originating from pads or pipelines parallel to the river channel to reach the river and be transported from to marine waters. Lease Stipulation K-4 requires a ¾ mile set back from the coast which would have a similar effect as K-1, reducing the potential for a large spill to reach marine waters.

4.6.10-a.4 Conclusion

Alternative D is expected to result in approximate 25% more surface disturbance and 15% more than Alternative B and 6% less than Alternative C; potentially distributed over a greater area of the planning area than either Alternative A or B, with a commiserate increase in barge traffic, aircraft, and spill potential, Therefore there is a greater likelihood of impacts to bowhead whales, including behavioral displacement from high-density foraging areas, injury, and mortality from ship collisions and oils spills. However, displacements are expected to be short-term and spills unlikely. Should they occur a relatively small proportion of the population is projected to be affected by these impacts. In those years where bowheads occur in shallower waters during fall migration, the number affected could be higher, but potential effects are not expected to be severe to lead to changes in the population unless a very large oil spill occurred in the marine environment.

4.6.10-b Spectacled and Steller's Eiders

4.6.10-b.1 Activities Not Associated with Oil and Gas Exploration and Development

Non-oil and gas activities that could affect spectacled and Steller's eiders under Alternative D would be the same as those listed under the other alternatives—private or commercial air traffic, aerial surveys to inventory wildlife or other resources, summer research camps, hazardous material or debris removal, subsistence hunting and fishing, and recreational camps and boating activity. Under Alternative D, a larger area would be available for permanent oil and gas facilities and development than Alternative A. However, the potential for non-oil and gas activities to disturb, displace, or cause mortality would likely be similar under all four alternatives. Lease stipulations and ROPs would mitigate some of the potential effects of non-oil and gas activities.

4.6.10-b.2 Oil and Gas Exploration and Development Activities

Seismic

The effects of seismic exploration on eiders is expected to be the same as under Alternative A as similar levels of seismic exploration are predicted for all alternatives (**section 4.2.1.2**) Although as with Alternatives B and C seismic could be conducted on Teshekpuk Lake this would be done over-ice – if at all. Because of the deferral of leasing of Teshekpuk Lake under this alternative, seismic work on Teshekpuk Lake is even more unlikely.

Exploration

Under Alternative D, the potential effects of ice-road and ice-pad construction would be greater than Alternative A, similar to Alternative B, and less than Alternative C, and would involve the temporary alteration of tundra vegetation. The potential effects of temporary habitat alteration on eiders may be greater under Alternative D than A or B because a large portion of the Goose Molting Area is opened, which is also an area of relatively high spectacled eider use, is closed to development under Alternative A and B. Therefore the associated impacts to eiders could also potentially be greater under Alternative D, but less than Alternative C.

Predators, such as glaucous gulls and Arctic foxes, could be attracted to anthropogenic food sources associated with summer maintenance of exploratory drilling and seismic equipment or winter exploratory activities. As with the other Alternatives with the performance-based ROPs and Lease Stipulations, the potential for increased predation of eiders by predators attracted to development would be reduced by ROP A-2, although the relatively greater amount of exploration drilling would increase the likelihood of predator attraction under Alternative D. The typical short time period and seasonality of exploration would reduce the likelihood that predators would discover any human provided food source as well as reducing the likelihood of predators persisting in the area because there would be no recurring anthropogenic food source. Furthermore since exploration is primarily a winter activity, avian nest predators would not be present, except for possibly common ravens.

Development and Production

Activities related to oil development and production in the planning area, such as vehicle, aircraft, pedestrian, and boat traffic, routine maintenance activities, use of heavy equipment, oil-spill clean-up activities, and aerial surveys to inventory wildlife or other resources, could

cause disturbances that would affect eiders. Under Alternative D, the types of disturbances to eiders would be the same as those discussed for the other Alternatives. These disturbances could result in temporary displacement from preferred foraging, nesting, or brood-rearing habitats, decreased nest attendance or nest abandonment, and increased energy expenditures that could affect physiological condition and rate of survival or reproduction. The likelihood for impacts to eiders would depend on the location of the disturbance, the number of eiders in the area, and the time of year. Under Alternative D, these impacts would likely be greater than Alternative A, similar to Alternative B, and less than Alternative C.

The potential for disturbance to threatened eiders from activities on roads and pads would likely be greater under Alternative D, as compared to Alternative A, because areas that support relatively high spectacled eider concentrations would be available for oil and gas leasing that are closed under Alternative A and only a small portion open under Alternative B. The large buffers placed around lakes that receive moderate to high use by molting geese somewhat off-set the effects of opening a greater area in that lakes in the Goose Molting Area have Restricted Surface Occupancy buffers extend ¼ to more than 1 mile depending on the lake (Map 2-4).

Lease Stipulation K-4 would also minimize disturbance by minimizing ground traffic from May 20 through August 20. In addition, Lease Stipulation K-6 would establish a ¾-mile buffer inland from the coast, within which permanent oil and gas facilities would be prohibited, to the extent practicable, to minimize hindrance or alteration of caribou movement within caribou coastal insect-relief areas. This lease stipulation could also help to reduce the potential impacts to eiders in nesting, molting, or brood-rearing habitats in coastal areas.

Development restrictions within the Teshekpuk Lake Caribou Habitat Area would protect eider habitat along in the northwestern corner of Teshekpuk Lake and along its western shore (Map 2-4).

As with Alternative B and C, Alternative D could also result in a greater level of disturbance to eiders in the Deep Water Lakes Area south of Teshekpuk Lake, than under Alternative A. Under Alternative A, no permanent oil and gas facilities would be permitted within ¼ mile of the any fish-bearing lake. Under Alternative D, facilities would generally not be permitted within this buffer, but could be permitted, on a case by case basis, in consultation with Federal, state, and NSB regulatory and resource agencies. Permitting facilities within the ¼-mile buffer of fish bearing lakes in the Deep Water Lakes Area could result in disturbance to eiders near the facilities and access roads. Although Lease Stipulation K-2 has been designed primarily to provide mitigation for deep-water fish habitat, it could also mitigate impacts to eiders using habitats near these lakes.

Air Traffic. The types of effects to eiders from aircraft would be the same as under other Alternatives and could include displacement from preferred feeding habitats, temporary or permanent nest abandonment, and temporary or permanent displacement from molting or brood-rearing areas. However, some eiders could either remain in habitats located near aircraft activities or move to nearby habitats. Although there is evidence that molting and staging geese are disturbed by aircraft (Jensen 1990, Ward et al. 1999) and pre-nesting eiders may respond to low flying (≤ 150 feet) aircraft (Balogh 1997). Evidence of adverse impacts to eiders is equivocal. Johnson et al (2006) found no indication that spectacled eider nests with higher levels of overflights had reduced nest success compared to those with no or less overflights. However, their dataset is short-term and it is reasonable to assume that some level of effect may occur under certain circumstances. Repeated flushing of pre-nesting birds may reduce nesting success, more sensitive birds may not nest or be displaced to lower quality nesting

habitat, and disturbance of molting eiders may result in greater rates of predation and reduced fitness with subsequent reduced migratory survival. None of these effects have been demonstrated, and would be very difficult to establish cause and effect relationships; however, here it is assumed that they are possible, but the magnitude (number of birds affected) and severity (likelihood of mortality/reduced recruitment) is unknown.

A greater number of eiders could be affected by air traffic under Alternative D than under A or B because of the greater area available for development. Even though a larger area would be available for oil and gas leasing and facilities could be located in areas where surface activity was prohibited under Alternative A and to a lesser extent restricted or prohibited under Alternative B, Lease Stipulations K-3 through K-6 would provide setbacks from various habitats surrounding Teshekpuk Lake and along the coast that are considered important for fish, birds, and caribou in the area. Within these setbacks, permanent oil and gas facilities would be prohibited, and other potentially disturbing activities, such as vehicular and air traffic, would be restricted. These lease stipulations would help to reduce potential aircraft disturbance to eiders, should oil and gas facilities be located within portions of the Teshekpuk Lake Special Area. However, if CPFs were located within the Teshekpuk Lake Special Area, the level of aircraft disturbance would likely increase along flight corridors and near airstrips located at these CPFs. Flight restrictions under Lease Stipulations K-4 and K-5 would be expected to also reduce the effects of aircraft in the Caribou Habitat Area/Goose Molting area. Lease Stipulation K-5 would place seasonal (May 20 – August 20 flight elevation restrictions (>2,000 feet except during take-offs and landings) and require an aircraft use plan showing minimization of flights in the Teshekpuk Lake Caribou Habitat Area.

Watercraft. Several types of watercraft could be used during the summer to transport equipment and supplies, to conduct oil spill response training drills. Summer barge traffic with the potential to temporarily displace molting eiders could occur in offshore waters of the planning area from mid-July through October. How eiders will react to boat traffic is unknown but the may react similarly to other waterfowl with short-term short-distance avoidance movements (Flint et al. 2003). Displaced eiders would probably move to adjacent habitats or return to original habitats after the barges passed though the area and barge traffic would not be expected to substantially impact molting eiders. There would be a greater likelihood for disturbance to molting eiders under Alternative D than under Alternative A because much of the area adjacent to the coast would be open for leasing under Alternative D but unavailable for oil and gas development under Alternative A. Therefore, it would be more likely that development would occur in portions of the Goose Molting Area, and that barge traffic would be required near this area for transportation of equipment and supplies during oil field construction and operation.

Oil spill response training activities using watercraft could be conducted on rivers and lakes several times during the summer open-water season. Under Alternative D, these activities would be more likely to disturb eiders than under Alternative A, because there would be a greater likelihood that facilities would be located in areas of spectacled eider concentrations within the Goose Molting Area.

Habitat Loss and Alteration

Under the development scenario for Alternative D the gravel footprint for roads, pads, airstrips, staging areas and gravel extraction sites is estimated to be approximately 4,378 acres; approximately 25% more than under Alternative A; 15% more than Alternative B; and 6% less than Alternative C. Loss of eider habitat would therefore be greater under Alternative D

compared to Alternative A and B, but less than Alternative C. The loss of habitat would be permanent in the area occupied by the development footprint, and eiders nesting in this area would be displaced to other areas. Their survival and future reproductive success would be dependent on the availability and quality of unoccupied habitat.

If spectacled and Steller's eider densities are assumed to be 2.0 and 0.02 birds per mi^2 (640 acres per mi^2) respectively (very high estimates based on aerial survey data; Larned et al. 2006; Ritchie and King 2003), up to 13.7 spectacled eiders and 0.2 Steller's eider could be expected to be displaced by the gravel footprint over the life of the plan if all development occurred in high density areas. This estimate is likely overly-conservative as areas of "high high" density make up only a small proportion of the planning area even with the entire area north of Teshekpuk Lake open under Alternative D (Map 3-33).

Alternative D would open the entire area north of Teshekpuk Lake but has substantial Restricted Surface Occupancy provisions (although pipelines) associated with Coastal areas, and lakes used by molting geese and caribou. Average eider density over 15 years in area north of Teshekpuk Lake is 0.79/mi^2. This area also contains approximately 57% of the indicated population within the Northeast NPR-A planning area (FWS, unpublished data). When this area is included the average Northeast NPR-A spectacled eider density is 0.36 eiders/mi^2. For comparison average spectacled eider density in the entire Eider Breeding Survey Area is 0.57 eiders/mi^2 (Larned et al 2006). Steller's eider densities are so low that estimates are not calculated from the Eider Breeding Survey (Larned et al. 2006), but they do occur within the planning area.

However, under all alternatives, the potential effects of habitat loss would depend on the location of the development, the types of habitat lost, and the level of eider use in the areas to be developed. Without specific information on the locations of potential developments, the estimates of eiders potentially impacted should be seen as an index of comparison between alternatives, not an absolute value of birds affected.

In addition to permanent habitat loss, temporary loss of tundra habitat adjacent to gravel roads and pads could occur as a result of thermokarst, dust deposition, snow accumulation, and impoundment formation. Under Alternative D, the types of effects to eiders resulting from temporary habitat loss would be the same as those discussed under Alternative A. As with permanent habitat loss, the degree of effects would depend on the location of gravel infrastructure and local use of adjacent habitats by eiders. However, impacts from the temporary loss of tundra habitat is projected to be greater under Alternative D than A and B because more areas with higher densities of eiders are available for oil and gas leasing. Lease stipulations and ROPs would help to mitigate potential effects of habitat loss to eiders.

Mortality

Compared to the Alternatives A and B, there would be an increased risk that eiders would collide with offshore barge and vessel traffic under Alternative D, as more area would be available for development north and east of Teshekpuk Lake that could increase the potential for development in that area and the amount of associated vessel traffic in offshore areas. Drill rigs and other tall structures would be present for a longer period of time and would increase the potential for collisions over other alternatives. As with Alternatives B and C, ROP E-11 would limit overhead lines and guywires and provide marking where they could not be avoided, thus reducing the threat from collisions

ROP E-10 would require illumination to prevent migrating waterfowl from colliding with drilling structures, production facilities, and other structures exceeding 20 feet in height. Although there is no similar action under Alternative A, the potential risk of eider collisions with oil field infrastructure could still be greater under the action alternatives because the potential benefits of illumination of facilities may not outweigh the presence of facilities within or near areas of high eider concentrations. There would also be an increased risk of eider collisions with vehicles under Alternative D compared to alternatives A and B because of the potential for road construction in the Goose Molting Area. The overall risk of eider collision with development related facilities or equipment would be reduced under Alternative D compared to Alternative C.

Some predators, such as ravens, gulls, Arctic fox, and bears, may be attracted to areas of human activity where they find anthropogenic sources of food and denning or nesting sites. The potential types of effects of increased predation to eiders under the Alternative D would be the same as those discussed under the other alternatives. Under Alternative D, impacts to eiders from predation are expected to be greater than Alternative A and B, and less than Alternative C. Although all alternatives have lease stipulations in place to eliminate attraction of predators to anthropogenic sources of food, under the action alternatives the lessee would be required to use the best available technology to prevent facilities from providing nesting, denning, or shelter sites for ravens, raptors, or foxes. There is no equivalent lease stipulation under Alternative A.

Effects of Abandonment and Rehabilitation

Winter activities would cause little disturbance or displacement, because eiders are absent from the area during the winter. However, ice roads could impound water and reduce habitat for nesting birds; such impacts would only affect nesting in the summer following ice road use. These impacts should be very minor, however, since most ice roads have melted prior to the time of nest initiation. Summer road and air traffic generated by abandonment and rehabilitation activities could cause disturbance, displacement, and mortality to eiders similar to, and at the same levels as, those described for traffic during construction and operations. If pads, roads, and airstrips were not revegetated, impacts to eider habitat would be permanent. If they were revegetated without removing the gravel, the habitat would not return to its historic use. If gravel was removed, habitat similar to that existing in the area could be created and used by eiders, although the habitat types would likely not be the same as what occurred in the area prior to disturbance. Alternative D would have an increased potential for adverse impacts to eiders from abandonment and rehabilitation compared to Alternative A due to the greater amount of pads and infrastructure. Alternative D would have similar but moderately more potential than Alternative B due the greater infrastructure and potentially greater spatial distribution but less than under Alternative C.

Effects of Spills

Oil spills would have similar types of effects to threatened eiders as under the other Alternatives. However, there would be an increased risk of a contaminant spill occurring under Alternative D. The potential for an offshore spill would increase because there would be approximately 20% more barge traffic under Alternative D than Alternative A. The risk of an onshore spill risk increases with increased volume of oil expected to be produced. The risk (or number of) large spills under Alternative D increases by about 27% (0.6 spill – see **section 4.2.2 – Oil Spills)** and the potential spill volume from large spills increases by 2,880 barrels

compared to Alternative A. An offshore spill would have the potential to spread through the action of wind and currents and could affect molting eiders in Harrison and Smith bays.

There could be an increased risk that an oil spill would occur and impact eiders in onshore habitats north and east of Teshekpuk under Alternative D, as compared to Alternatives A and B, as more of this area would be available for leasing under Alternative D. In the remaining portion of the planning area, the potential effects of an oil spill to eiders would be similar under all alternatives, although eider density is lower. Excluding the Goose Molting Habitat Area and Teshekpuk Lake Special Area, the areas available for leasing would be the same under all alternatives, and similar lease stipulations would apply. There would be a greater potential that an oil spill would occur and impact eiders in the Deep Water Lakes Area south of Teshekpuk Lake under Alternatives B, C and D than Alternative A, as a facility could be permitted within the ¼-mile buffer around fish-bearing lakes under the action alternatives. However, Lease Stipulation K-2, which would apply to the Alternatives B, C, and D and would prohibit permanent facilities within ¼ mile of fish-bearing lakes without prior consultation with regulatory agencies. The potential for an offshore or terrestrial spill to impact spectacled and Steller's eiders would be less under Alternative D compared to Alternative C.

Oil entering a river or stream could potentially spread into delta or coastal areas where impacts to threatened eiders could be more severe. Lease Stipulation K-1 would help reduce the likelihood that an oil spill would enter a major river or stream. This lease stipulation would provide setbacks of ½ to 3 miles from specified rivers, within which permanent oil and gas facilities would be prohibited, although pipelines could be permitted in some of these areas.

Commercial Gas Development

Gas development would have impacts on eiders similar to that described for oil development, except that there would be no impacts from oil spills. Any effects of natural gas development and production on spectacled and Steller's eiders are expected to be limited to temporary, nonlethal effects, perhaps resulting in disturbance to a few birds. However, a natural gas well blowout occurring from June to September could affect eiders that are nesting, rearing young, staging, or migrating. Some mortality could result from such an incident, although it is likely that no more than a small number of individuals would be affected. Such impacts to eiders would be more likely in alternatives B, C, and D, which make important eider habitat available for leasing north and east of Teshekpuk Lake than Alternative A.

4.6.10-b.3 Effectiveness of Stipulations and Required Operating Procedures

Under Alternative D, almost the same lease stipulations and ROPs that apply to alternatives B and C would apply. These measures should be equally, more, or less effective than the lease stipulation measures developed for Alternative A when viewed individually. In total they should be considered different but likely to achieve similar protections although in different areas and with different means. Most ROPs and Lease Stipulations that would reduce impacts to eiders have been discussed in previous sections. Additional discussion is provided here for ROP E-11 and Lease Stipulation K-4.

ROP E-11 is specific to eiders. It requires pre-construction surveys for 3 years which will assist in facility and infrastructure placement to avoid eiders. It also requires minimizing overhead lines and guywires. Transmission lines are required to be attached to VSMs or buried off-pad and marking devices are required for guywires. These requirements substantially reduce the

collision risk by limiting hard to detect overhead transmission wires and making guywires more visible.

Under Alternative D, a buffer around goose molting lakes within which permanent oil and gas facilities (except pipelines) would not be permitted would help mitigate impacts to spectacled and Steller's eiders from the effects of development in these areas. These buffers are equal to (1/4 mile or larger >1 mile) than the buffers under K-4 for Alternative B and C. However, portions of the Goose Molting Area that receive protection under alternatives A and B would be open to surface occupancy under Alternative D. The highest spectacled eider concentrations in the planning area occur in the Goose Molting Area and development in this area could result in a higher level of disturbance to eiders than would occur under alternatives A and B. In addition, under Alternative D, pipeline construction would be permitted in the entire Goose Molting Area, which could result in increased levels of disturbance and habitat loss as well as increased potential for an oil spill in an area of high eider use. The area east and southeast of Teshekpuk Lake in the caribou habitat area, where surface occupancy is restricted, would also provide some protection for disturbance and habitat loss for eiders although spectacled eiders occur in low to moderate densities in this area.

4.6.10-b.4 Conclusion

Under Alternative D the types of disturbances related to vehicle, aircraft, pedestrian, and vessel traffic, routine maintenance activities, heavy equipment use, facility noise, and oil spill clean-up activities would be the same as those that would occur under the other alternatives. The potential for these disturbances to impact spectacled and Steller's eiders would be greater under Alternative D, compared to alternatives A and B, because a greater portion of high eider use areas in the Goose Molting Area would be available for leasing and development under Alternative D. Under Alternative D, these impacts would be reduced compared to Alternative C.

The potential for habitat loss and alteration to affect eiders would be greater under Alternative D compared to alternatives A and B because there would be a greater potential for infrastructure to be located in areas of high eider use in the Goose Molting Area. In addition, road and pipeline construction could occur throughout the Goose Molting Area, which could result in further loss of eider habitat and increased levels of disturbance. The potential for eider mortality resulting from collisions with vehicles and/or infrastructure and marine vessel traffic would also be greater under this alternative than under alternatives A and B. Under Alternative D, development related impacts to spectacled and Steller's eiders would be less compared to Alternative C.

In general, impacts to eiders from non-oil and gas activities, and from oil and gas activities, would likely be additive, except in those areas where the two types of activities overlapped. Impacts to eiders from exploration and development activities would also be additive, except where development activities occurred in areas previously disturbed during exploration. However, once exploration and development/production ceased in an area, bird populations and habitat could recover, reducing overall effects in the planning area. In areas where two or more activities occurred, overall impacts would reflect those impacts associated with the first activity and any new impacts associated with later activities. Because of the potential for disturbance in a larger portion of the Goose Molting Area, impacts to eiders under Alternative D would probably be slightly greater than Alternative B, and much greater than under Alternative A. Under Alternative D, impacts to eiders would be less compared to Alternative C.

4.6.10-c Polar Bears

4.6.10-c.1 Activities Not Associated with Oil and Gas Exploration and Development

Subsistence hunting and disturbance of denning bears resulting from winter overland travel likely have the most effect on bears in planning area. There is no record of where bears are taken, so the how subsistence take impacts bears in or near the planning area is unknown, but on average 32 polar bears from the Southern Beaufort Sea stock are taken annually in Alaska (Angliss and Outlaw 2005). Winter overland travel not in support of oil and gas is likely relatively rare in the planning area and unlikely to result in significant disturbance effects. Research activities and close passes (<1 mile) may cause abandonment of a den if they occur early in the season but do not appear to have significant effects later in the season (Amstrup 1993).

4.6.10-c.2 Oil and Gas Exploration and Development Activities

Seismic

Under Alternative D, a small number of polar bears could be affected by seismic exploration occurring along the coast, although ROP C-1 would prohibit seismic activities within one mile of known or suspected polar bear dens or seal birthing lairs.

Exploration

Under Alternative D, increased levels of exploratory drilling and development that could occur near the coast would increase the likelihood of displacing or attracting polar bears or causing den abandonment compared to Alternative A. Most polar bear dens near the planning area are off the coast, north of Teshekpuk Lake. The effects of exploration activities, including disturbance and potential spills, would depend on the scale and duration of the activity and could affect some marine mammals.

Development and Production

Female polar bears denning within approximately one mile of construction activity could be disturbed by vehicle traffic and construction noise. If disturbance leads to premature abandonment of the den it could result in the potential death of cubs (Amstrup and Gardner 1994). The relatively greater amount of development anticipated under Alternative D compared to Alternative A or B increases the likelihood that activities associated with oil and gas have greater impacts on denning polar bears. However, the required set-backs under Lease Stipulation K-1 and K-4 from major rivers and the coastline respectively would reduce the likelihood of construction destroying potential den sites. Polar bears could be attracted to drill sites by food odors and curiosity, increasing the potential for negative human-bear interactions, and the possible death of bears in defense of human life and property. However, under current rules, policy, and practice there has not been a DLP taking reported in the Alaska oil fields (Schliebe et al. 2006)

As under other Alternatives, consultation between oil field developers and the USFWS would result in the use of nonlethal means of deterrence if necessary.

Contaminant Spill

Female polar bears select "bluffs" including river banks for denning habitat, thus they are more likely to be present in river drainages. Any spill that reached a river during late fall when polar bears are constructing dens, occurred in winter under ice, or in spring during broken ice periods could impact denning polar bears and their young if the spill was large enough to reach the den area in sufficient concentration. The potential for a spill is increased under Alternative D compared to Alternatives A and B due to the greater amount of oil expected to be produced.

Spring or summer spills that reached marine waters would have the greatest likelihood of impacting polar bears or their prey. Spills during broken ice or in the lead system would have the largest potential for adverse effect.

Polar bears are generally widely dispersed, thus any spill would be unlikely to affect more than one to three bears.

Effects of Abandonment and Rehabilitation

Effects would generally be the same as under construction. Dismantling of equipment and modules and readying it for transport would most likely take place during summer. Transport of large or heavy material would be a winter activity and occur over ice roads. Any re-contouring or removal of gravel would primarily be done in the winter, although some summer activity may be necessary to finish. Any planting or monitoring would also be a summer activity. A combination of surface vehicles and aircraft would be required for transportation. The potential for large spills would be substantially reduced after shut-down.

Because more development is predicted and could occur over a larger area than under Alternative A or B, Alternative D has a greater likelihood of impacting polar bears during abandonment and rehabilitation but less than Alternative C. Some disturbance of denning bears could occur, and there is a possibility of a DLP taking; however, under no case is the level of effect expected to cause population level responses.

Commercial Gas Development

If natural gas development and production occur in the coastal areas used by polar bears, potential impacts would include those described above for oil development, such as attraction to waste from the facilities, though there would be no oil spill impacts. Denning female bears may be encountered during winter construction or maintenance activities. Aroused female bears may abandon the den, potentially leaving cubs. Additionally, increased energy expenditure could negatively impact the cub survival. Because more lands near the coast would be available for oil and gas development under this alternative than in Alternative A, there is greater potential for impacts to polar bears than under Alternative A. If gas development occurs in rough proportion to that projected for oil development, there would be more impacts under this alternative than in Alternatives A and B, but less than for Alternative C.

4.6.10-c.3 Effectiveness of Stipulations and Required Operating Procedures

Alternative D would include the same performance based ROPs and Stipulations as Alternative B and C. ROP A-1 would minimize the potential for food waste to attract polar bears and the need for deterrence or take. The ROP is similar to current practice within the Prudhoe oil fields

which has resulted in few deterrence actions and no DLP takings since implemented (Schliebe et al 2006).

Required Operating Procedure C-1 would prohibit the cross-country use of heavy equipment and seismic activities within 1 mile of known or observed polar bear dens or seal birthing lairs. This ROP would also require operators to consult with the USFWS before initiating activities in coastal habitat between October 30 and April 15. Letters of Authorization reinforce the ROP and may result in area specific restriction that would further reduce the likelihood of adverse affect.

The K-1 Lease Stipulation would require 1-3 mile setbacks from the major rivers the planning area. This is expected to reduce the potential for disturbing denning bears in these areas. Pipelines could still cross these areas so the likelihood of a spill from a transport pipeline is possible but spills from accidents on pads, parallel pipelines or at compressor stations would be very unlikely to reach the river banks.

Lease Stipulation K-6 would prohibit the placement of permanent facilities within ¾ mile of the coast, except where technological limitations, economics, logistics, or other factors necessitated a structure. Under these circumstances, the use of a previously occupied site (Camp Lonely, Husky/USGS drill sites, and DEW-Line sites) would be considered. The elimination of new permanent facilities within ¾ mile of the coast should be effective in reducing the potential for disturbance to polar bears and their prey and is expected to reduce the potential for disturbance (displacement or attraction) of polar bears along the coast.

4.6.10-c.4 Conclusion

Under Alternative D, ROPs and lease stipulations (as described under "Effectiveness of Stipulations and Required Operating Procedures") would prohibit the construction of permanent structures within ¾ of a mile of the coast, although exploration could occur in the area. The effects of exploration activities, including disturbance and spills, would be localized and would be unlikely to affect populations. Individual polar bears could be affected by exploration activities and seismic surveys in close proximity to polar bear dens and could cause abandonment of maternity dens by polar bears. Avoidance requirements are expected to result in only a small number of dens being affected.

A greater area would be affected under Alternative D than under Alternative A or B. The opening of the area north of Teshekpuk Lake would allow development in areas where polar bears are most likely to occur; however, coastal buffer and river buffer requirements should reduce the potential for adverse effects. The ROPs and Stipulations combined with the relative low density of denning bears near the planning area make it unlikely that Alternative D would have a significant effect on polar bear populations.

4.6.11 Cultural Resources

4.6.11.1 Activities Not Associated With Oil and Gas Exploration and Development

Aircraft and watercraft traffic, scientific investigations (e.g., archaeological and paleontological surveys and excavation), summer camps, hazardous and solid waste material removal and

remediation, overland moves, and recreation could cause effects to cultural resources. The effects of these non-oil and gas activities on cultural resources under Alternative D would be the same as those occurring under Alternative A. There would be no difference in the occurrence of recreational use between Alternative A and Alternative D. However, a greater amount of scientific work could occur in the planning area under Alternative D than in Alternative A (though less than in Alternative C) as exploration increases along with other management activities by BLM. As a result, there would be a greater likelihood of effects to cultural resources in the planning area under Alternative D than under Alternative A.

4.6.11.2 Oil and Gas Exploration and Development Activities

Under Alternative D the amount of area available for exploration along a geological feature known as the Barrow Arch, which is anticipated to hold significant deposits of hydrocarbons, would be greater than under Alternative A. The amount of land anticipated to receive surface impacts, though less than in Alternative C, would be greater than that for Alternatives A and B. Consequently, under Alternative D the likelihood of impacts to known and undocumented cultural resources would be greater than in all alternatives except Alternative C.

Effects of Disturbances

Under Alternative D the level of disturbance associated with oil and gas exploration and development activities in the planning area is anticipated to be about 25% greater than under Alternative A, 15% greater than under Alternative B, but 5% less than under Alternative C. However, because most of the oil and gas activities would occur during the winter months when buried cultural resources are protected by snow cover and frozen soil, the potential for effects to buried cultural resources would be minor. As discussed for Alternative A, the likelihood of oil and gas activities affecting surface cultural resources would be minor because of the isolated occurrence of these resources and because of the variety of lease stipulations and ROPs that would govern oil and gas exploration activities.

Under Alternative D the types of effects of possible disturbance would be the same as those occurring under Alternative A. Efforts to supply necessary materials for construction of gravel pads, airfields, and roads at this scale could increase the likelihood of damage to known or undocumented cultural resources in the planning area. The excavation of gravel material for the construction of the permanent facilities would be a primary source of potential effects to cultural resources. Pipelines would not have associated all-weather gravel roads or pads and would be constructed during the winter months from an ice road and pads. Therefore, the only effects on cultural resources resulting from aboveground pipeline construction would be associated with the placement of VSMs, and would depend on the depth at which the VSMs were set.

Effects of Abandonment and Rehabilitation

It is unlikely that cultural resources would be impacted by abandonment activities unless the facilities to be abandoned or removed during rehabilitation were themselves historic.

Effects of Spills

Under Alternative D the effects of oil spills on cultural resources would be the same as those that would occur under Alternative A, though because there is an increased chance for more spills and more spilt oil, there would be a corresponding marginal increase in the potential

impacts to cultural resources. In the exploration stage, most spills would occur on an ice pad or ice road and during winter conditions. In such a case, the spill or subsequent spill cleanup would probably not alter or destroy buried cultural resources. Warm oil, however, could melt through the snow and ice and impact cultural resources buried near the surface. An oil spill could affect surface cultural resources by covering these resources with oil or other spill material. A spill occurring during the summer would have a greater potential to affect surface and subsurface cultural resource sites than a spill occurring during the winter because the effects of both the spill and subsequent cleanup would be greater. Oil spills on cultural resource sites would cause damage proportional to the extent of contamination, and could require data recovery (excavation) as part of remediation and clean-up efforts. However, irreparable damage to some of the data could occur. Oil spills at cultural resource sites, either surface or buried, could make radiocarbon dating of that site problematic or impossible.

Commercial Gas Development

The types of impacts on cultural resources that natural gas development and production would cause would be the same as those caused by oil development described above, except that there would be no crude-oil spills, impact from creation of gravel pads would be increased for a 10- to 20-acre pad for a pipeline compressor station, and if a gas pipeline is buried—the likely method—there would be additional acreage disturbed with increased potential for disturbance or destruction of cultural resources. As with Alternatives A and B, it is anticipated that burying the pipeline would result in digging up approximately 162 miles of four feet wide and five feet deep trench (approximately 80 acres) and potential surface disturbance of 210 acres in areas adjacent to the trench from potential disturbance from machinery or placement of backfill. The risk to cultural resources would be reduced dramatically if gas pipelines are put on VSMs.

4.6.11.3 Effectiveness of Stipulations and Required Operating Procedures

Under Alternative D several lease stipulations and ROPs would minimize the effects of oil exploration and development activities on cultural resources. Required Operating Procedure E-13 requires that a survey for cultural resources be conducted prior to any ground disturbing activity. Required Operating Procedure I-1, which corresponds to Lease Stipulation 63 of Alternative A, would be effective in reducing cultural and resource conflicts through an orientation program for personnel that would teach the importance of not disturbing archaeological resources, as well as sensitivity to community values, customs, and lifestyles. The "K" lease stipulations would require setbacks along rivers, streams, lakes, cabins, and the coast, providing effective protection to cultural resources in these areas. Lease Stipulations K-1, K-2, K-3 and K-7 would effectively minimize the loss of cultural resources through setbacks from certain rivers, lakes. Additional "K" lease stipulations (K-8, K-9, and K-10) would apply to areas previously unavailable for leasing under the 1998 Northeast IAP/EIS ROD, but available for leasing under Alternative D. Lease Stipulation K-9 would protect an area with a large number of cultural resource sites on the east side of Teshekpuk Lake from surface occupancy and would prohibit permanent oil and gas facilities, including major ROW, such as pipelines and major roads. However, Lease Stipulations K-4(h) and K-10, while prohibiting permanent oil and gas facilities within the RSO area, could allow ROW for pipelines in areas with concentrations of known cultural resources. In addition, Lease Stipulation K-11 would allow up to 300 acres of permanent surface disturbance in each of seven lease tracts north of Teshekpuk Lake, except in those areas of the Goose Molting Area that would be off limits to surface development. Cultural resources have been documented in the proposed lease tract areas (see Map 3-34).

Prior to any undertaking (i.e., ground-disturbing activities such as the construction of buried pipelines, all weather gravel roads, and gravel well pads) on Federal lands, the NHPA would require that an archaeological resource survey be completed. If cultural resources were identified during such a survey, BLM guidelines and policy would require that all impacts to these resources be mitigated to the satisfaction of the land manager and the State Historic Preservation Officer.

4.6.11.4 Conclusion

The probability of impacts to known and undocumented cultural resources would greater under Alternative D as compared to alternatives A and B, because of the increase in the amount of land that could be impacted, but less than that for alternative C. Effects to cultural resources from oil and gas activities could occur in leased areas of the planning area and would continue for the duration of operations through abandonment. Known cultural resources would not be affected, but the presence of undocumented cultural resources in the planning area cannot be discounted. Multiple sales over the available portions of the planning area increase the likelihood of effects to undocumented cultural resources.

Approximately 2 to 3% of the planning area has been surveyed for cultural resources. The distribution of known cultural sites does not reflect locational preference of prehistoric and historic people, but rather indicates that only portions of the planning area (e.g., well sites, portions of the coast, the Colville River, the Ikpikpuk River, and the Teshekpuk Lake area) have been examined through some type of organized reconnaissance for the presence of cultural sites. The TLUI sites generally cluster in these same areas with greater density on the lower Ikpikpuk River and associated drainages (NSB 1978, 2003). Activities that could occur near these areas may have a greater likelihood of impacting cultural resources. For example, the Teshekpuk Lake Special Area contains a high density of documented archaeological, historical, and TLUI sites (see Map 3-34), and is likely to have a high density of undocumented archaeological, historical, and TLUI sites. Exploration and development activities in the Teshekpuk Lake Special Area could impact these known and undocumented cultural resources.

In general, impacts to cultural resources from non-oil and gas activities, and from oil and gas activities, would likely be additive, except in those areas where the two types of activities overlapped. Impacts to resources from exploration and development activities would also be additive, except where development activities occurred in areas previously disturbed during exploration. In areas where two or more activities occurred, overall impacts would reflect those impacts associated with the first activity and any new impacts associated with later activities. Because of the larger disturbance area and the potential for more oil and gas exploration and development activities, potential impacts to cultural resources under this alternative would be greater for oil and gas exploration and development activities as compared to Alternative A. Impacts could increase, too, if oil and gas exploration and development activities occur in an area with a high concentration of cultural resources, such as the Teshekpuk Lake Special Area. These impacts would be effectively mitigated by lease stipulations and ROPs that prohibit oil and gas exploration and development in areas with a high likelihood of having cultural resources: enforcement of lease stipulations and ROPs that prohibit collection of artifacts and require training of workers regarding avoidance of effects on cultural resources; and compliance with all Federal laws, including the National Historic Preservation Act, which requires surveys for cultural resources in areas where ground-disturbing activities are proposed.

4.6.12 Subsistence

4.6.12.1 Activities Not Associated With Oil and Gas Exploration and Development

Under Alternative D, non-oil and gas activities requiring permits from the AO could be subject to the stipulations outlined in Appendix F, as well as any other applicable Federal, state, and NSB regulations. Activities not associated with oil and gas exploration and development include: aircraft and watercraft use; research activities, including remote camps associated with research; overland moves; solid and hazardous waster removal, and recreation. All of these activities have the potential to affect subsistence use. See **section 4.1** for a detailed description of the types of non-oil and gas activities that may occur in the planning area.

Effects of Disturbances

Aircraft Use. Under Alternative D, the effects of aircraft use would be similar to that described under Alternative A, although it would have a greater potential to interfere with subsistence species and hunters, should research increase. The opening of areas to the north and west of Teshekpuk Lake could increase the amount of aircraft disturbance to subsistence species, relative to Alternative A, thereby affecting Nuiqsut, Atqasuk, and Barrow subsistence users (see Maps 3-36, , 3-37, 3-38, 3-39, 3-40, 3-41, and 3-42). Aircraft could divert caribou that are migrating or caribou in insect relief areas, as well as seals, walrus, and whales from subsistence use areas. This would increase the number and duration of trips needed to maintain the level of subsistence harvest necessary to support the community. In addition, subsistence users could have to travel farther to harvest subsistence foods, resulting in more time spent in pursuit of subsistence species, increased stress and anxiety of subsistence user, loss of money, increased costs in fuel and time, and increased risk of equipment failure and meat spoilage, and increased risk of possible loss of life or serious bodily injury. If subsistence resource users have an emergency far from existing communities and facilities, rescue efforts must be mounted by the NSB with the help of the nearest communities at increased cost due to increased travel distances, along with increased risk of possible injury or loss of life for rescue personnel. Nuiqsut subsistence users have repeatedly stated during scoping meetings that aircraft traffic reduces harvest access and success (Nukapigak 1998, Ahtuangaruak 2003, Kaigelak 2003, Olemaun 2003).

Watercraft Use. Under Alternative D, the effects of watercraft on subsistence harvest patterns would likely be the same as those discussed under Alternative A.

Research Activities. As baseline data are gathered preparatory to further lease sales under Alternative D, scientific research and data collection could increase as compared to Alternative A. Clearance and inventory of cultural resources would increase in anticipation of further lease, development, and exploration activity in the planning area. Biological research and monitoring would increase to expand baseline data for future effects monitoring. The result of increased research and data collection would be temporary and would include localized diversion, deflection, or disturbance of subsistence users and species, including caribou, moose, wolf, wolverine, muskox, and spotted seals (USDOI BLM 2003a).

The amount of scientific research and data collection associated with lease sales would likely be greater under Alternative D than under Alternative A. Therefore, there would be an increased likelihood that these activities would affect subsistence users and species. Research activities would predominately take place in the summer months. Aircraft-based biological surveys have

the greatest likelihood of affecting subsistence harvest patterns because they cover a large area, last a long time relative to other research activities, and are known to elicit responses from caribou and waterfowl (Nukapigak 1998, Ahtuangaruak 2003, Kaigelak 2003, Olemaun 2003). Archaeological, paleontological, and geological activities involving personnel walking on tundra would have effects on subsistence species for the duration of the activity.

Recreation. Under Alternative D there could be more recreation in the planning area than under Alternative A in response to publicity, but it would likely be limited to summer use of river corridors. Recreation would result in a temporary and local effect on subsistence species.

Similar to Alternative A, recreational users would likely frequent waterways used by subsistence hunters during the summer months, potentially causing resource user conflicts. The effects of these conflicts on subsistence harvest patterns would likely be localized and of short duration. Since the amount of recreation that would occur would be more or less the same under Alternatives A and D, effects to subsistence harvest patterns would also be much the same.

Waste Removal. Solid and hazardous waste removal and remediation, such as monitoring of existing clean-up sites and aging infrastructure (e.g., wellheads), would be ongoing and independent of additional lease availability. The effect of solid and hazardous waste removal and remediation on subsistence species under Alternative D would be similar to those that would occur under Alternative A. Over the short term, a localized deflection of subsistence species could occur. Long-term effects could include a decreased potential for contamination of subsistence species with the cleanup of waste sites.

As discussed under Alternative A, solid and hazardous waste removal and remediation activities would have localized effects that would last for the duration of the activity. Evaluation activities would have little effect on long-term harvest patterns. Site cleanup and remediation activities could temporarily divert or disturb caribou, muskox, and grizzly and polar bears, but would have little effect on long-term subsistence harvest patterns.

Overland Moves. Similar to Alternative A, overland moves would occur only by permit and would be subject to stipulations and ROPs. Stipulations and ROPs would mandate procedures to protect denned bears and minimize impacts to caribou. However, overland moves could temporarily deflect local subsistence species when they occur. Overall, the effects of overland moves on subsistence harvest patterns would likely be similar under all alternatives.

Conclusion

The effects of non-oil and gas activities on subsistence species would be similar to those that would occur under the Alternative A. Activities would be, in most cases, of limited duration and magnitude, and effects on subsistence species would be limited to the immediate area of the activity. However, the duration, extent, and magnitude of effects could be slightly greater under Alternatives B, C and D than under Alternative A. Under all action alternatives, aircraft traffic could increase during summer to support activities (such as scientific research) that would be required prior to expanding lease areas, resulting in increased effects to subsistence species through temporary and localized diversion, deflection, or disturbance of animals.

Non-oil and gas activities that could affect subsistence harvest patterns include aircraft use and scientific research and data collection. As discussed Alternative A, these activities could alter the availability of subsistence species in traditional harvest areas through direct interference with hunts. This direct interference could affect harvest patterns by requiring hunters to travel

further, because the subsistence resources are more wary than normal following a disturbance or are deflected from traditional harvest areas following the presence of vehicles, vessels, and aircraft. Nuiqsut residents have noted that aircraft have diverted subsistence resources away from areas where hunters were actively pursuing them, directly interfering with harvests or causing harvests to fail (USDOI BLM 2004C). Increased travel distances would result in greater expenditures for fuel and equipment, as wear and tear on snowmobiles, outboards, and four-wheel vehicles would occur.

4.6.12.2 Oil and Gas Exploration and Development Activities

Alternative D makes available approximately 95% (approximately 4,389,000 acres) of the planning area's 4.6 million acres for oil and gas leasing. Management practices would emphasize performance-based stipulations and ROPs on surface activities, consultation with local residents, and coordinated scientific studies to protect wildlife habitat, subsistence use areas, and other resources. Under Alternative D, Teshekpuk Lake (approximately 211,000 acres) would be deferred from leasing. This deferral would preclude exploratory drilling and pipeline construction. Current leases are not affected by the deferral.

Alternative D makes available approximately 389,000 acres that were unavailable in the 1998 ROD. The additional lands made available by Alternative D are within the area of highest oil and gas potential in the Northeast Planning Area, and are within the Teshekpuk Lake Special Area (TLSA). Several major protective measures, including the creation of larger lease blocks and a cap on the number of acres of disturbance allowed in each block, have been developed to protect important resources and subsistence activities in the TLSA (see **section 2.3.4** for a description of these protective measures).

Effects of Disturbances

Aircraft Activity. Disturbance from aircraft activity related to oil development would be greater under Alternative D compared to Alternative A, as new areas within the planning area would be available for oil and gas leasing. Activities related to aircraft use could disturbed subsistence activities which could in turn impact subsistence users. Some of these impacts include loss of money, loss of time, loss of subsistence food, increase cost in fuel, increased degradation on equipment, increase stress and anxiety and increase risk of loss of life or serious injury. These impacts could lead to a greater need for emergency search and rescue responsibilities by local governments.

Seismic Survey Activity. Under all alternatives, it is anticipated that five additional seismic surveys, three 2-D and two 3-D, would be conducted within the planning area in order to cover all gaps where seismic has not yet occurred. The three 2-D surveys are projected to potentially impact a total of 8,126 acres, which is the combined total of acres impacted by the survey and acres impacted by the camp train overland move. The two 3-D surveys are estimated to potentially impact a total of 99,870 acres, combined. It is also assumed that the surveys would occur in those areas currently not covered by 3-D surveys, which include the foothills area and the area north and east of Teshekpuk Lake (see Figure 4.6). The area north of Teshekpuk Lake is favorable habitat for denning polar bears. The South Beaufort polar bear sub-population is an important subsistence resource that could be affected by seismic activity under Alternative D. According to Schliebe et al. (2006) oil exploration and development occurring in near-shore environments within the South Beaufort Sea polar bear sub-population range is a conservation concern. The effects of seismic exploration under Alternative D could be greater than those described under Alternative A (see **section 4.3.12.2**).

Exploratory Drilling. Under Alternative D it is estimated that 110 exploratory wells will be drilled in the planning area, with an additional 83 delineation wells drilled in subsequent years near wells that showed potential as oil producers. Wells that do not indicate the presence of hydrocarbons in developable quantities will be plugged and abandoned. Wells that show potential may be "suspended," and capped with what is known as a "Christmas tree" at the surface. It is anticipated that, at most, 7 drill rigs will be operating in the planning area in any given winter season, an increase (relative to Alternative A) of 2 rigs under this alternative.

Impacts as a result of exploratory drilling under Alternative D will be identical to those described under Alternative A; however, given the increase in proposed activity, the effects on subsistence use and species would be greater in magnitude, extent, and duration. Subsistence species that may be affected include caribou, wolves, wolverines and polar bear. In addition, opening the entire planning area to exploratory drilling increases the likelihood of subsistence user conflicts with oil and gas activities. And, as discussed under Alternative B, the more anticipated activity, the greater the increase in conducting necessary studies prior to the winter drilling season (see **section 4.4.12.2**). The effects as a result of Alternative D would be greater than Alternatives A and B, but slightly less than Alternative C.

Development and Permanent Facilities. The effects of oil and gas exploration and development activities on subsistence uses and harvests in the Northeast NPR-A under Alternative D would be greater in magnitude, extent, and duration than under Alternatives A and B, and less than under Alternative C. All areas that were unavailable for year-round occupation and development under Alternative A, except Teshekpuk Lake, would become available under Alternative D, and subsistence uses in these areas could be affected by oil and gas development. The primary effect of oil and gas development activities in the area surrounding Teshekpuk Lake would be to deflect subsistence users from the vicinity of development pads, roads, and pipelines. In addition, these facilities could deflect caribou from their normal migration, calving, insect-relief, and grazing areas. Development activities may also deflect the caribou from subsistence harvest areas used by Nuiqsut, Atqasuk, and Barrow residents. Pipelines, pads, and roads may concentrate caribou during certain seasons in areas where they would not likely be harvested by subsistence users due to prohibitions against hunting in industrial areas and fears of accidents and contamination. Development near Teshekpuk Lake could also affect subsistence uses of fish, waterfowl, and seals in areas near exploration, development, and production activities.

Subsistence users tend to avoid areas of oil infrastructure and activity for the reasons noted in Alternative A. Hunters from Nuiqsut, Barrow, and Atqasuk would be directly affected by development in the Teshekpuk Lake area, where numerous subsistence camps, cabins, and ice cellars are located. Nuiqsut subsistence users have stated during scoping meetings and public testimony that air traffic reduces harvest success (Nukapigak 1998, Ahtuangaruak 2003, Kaigelak 2003, Olemaun 2003). Based on data from Pedersen et al. (2000) and Pedersen and Taalak (2001), as a consequence of oil development, Nuiqsut caribou harvesters tend to avoid development, with approximately 78% of the 1993 and 1994 caribou harvests occurring greater than 16 miles from the development east of the Colville River. More recently, 51% of the 1999-2000 harvests occurred greater than 16 miles from the Alpine field and 27% occurred 6 to 15 miles from the Alpine field. Oil and gas development could divert subsistence users a distance of 5 to more than 25 miles from facilities.

Nuiqsut, Barrow, and Atqasuk subsistence users harvest wolves and wolverines in the planning area. These species could be displaced by development in the area (Brower 1997). Alternative D would have a greater effect on subsistence caribou harvests than Alternative A, and similar to

Alternatives B and C, because the areas of potential activity would be large, the duration of oil and gas activity in the area could be longer, and the geographical extent of possible development (from the Colville River to the Ikpikpuk River surrounding Teshekpuk Lake) would be greater.

Waterfowl could be affected by activity in newly-opened areas during construction and production. Helicopter traffic and persons walking on tundra or gravel pads would be the most likely sources of disturbance to nesting and molting waterfowl (USDOI BLM and MMS 2003). Development under Alternative D has the potential to have greater effects on black brant, which are an important subsistence resource. The communities of Point Lay, Wainwright, Barrow, and Nuiqsut harvest brant as they move to and from molting areas north of Teshekpuk Lake. Effects to black brant in their molting area may have impacts on the subsistence use of brant in other parts of the state, including communities on the Seward Peninsula or the Yukon-Kuskokwim Delta. Increases in predator populations near developed areas could cause locally severe nesting failures and elevated predation on waterfowl in developed areas (Burgess 2000, Johnson 2000b). However, these effects should be relatively minor, geographically widespread, and occur during the relatively brief period when these animals are present in the area. Some aspects of oil and gas development could create new habitat favorable to waterfowl survival, such as reclaimed gravel pits and water impoundments near roads (Johnson 2000a, b; McKendrick 2000; Ritchie and King 2000; Sedinger and Stickney 2000). Reclaimed gravel pits complicate some subsistence harvests, however, by making it difficult to recover waterfowl from the deep lakes left behind. A possible indirect effect of development in the Teshekpuk Lake area would be the placement of restrictions on harvests of waterfowl on the North Slope, the Yukon-Kuskokwim Delta areas, and along the Pacific Flyway, in response to reduced waterfowl populations. These restrictions would reduce subsistence harvests (USDOI BLM and MMS 1998).

Subsistence fish harvests take place in all seasons, primarily in freshwater rivers and lakes. Nuiqsut's primary harvest area for fish is located in the northeast quarter of the planning area, in the Colville River and its delta channels and Fish and Judy creeks, where development is already in the planning stages. A loss or reduction in Nuiqsut's fish harvest would be a hardship for the community, as fish provide approximately 30-40% of all subsistence harvest by weight in the community (see **section 3.4.2**). Barrow residents harvest fish during caribou harvest activities along the coast and in the Teshekpuk Lake and Chipp and Ikpikpuk river areas (see Map 3-39), and they receive fish in trade from Nuiqsut residents. Atqasuk residents fish in several lakes near Teshekpuk Lake and in the Chipp and Ikpikpuk rivers (SRBA 2003b). Under Alternative D, development activities could impact fish harvest patterns; however, the lease stipulations and ROPs should be effective in protecting fish numbers to ensure availability for subsistence harvests. More development in previously restricted areas may deflect subsistence users from harvest areas and impede access for subsistence users, however. Therefore, effects of Alternative D on subsistence fishing could be greater than those described under Alternative A, and similar to Alternatives B and C.

As noted under Alternative A, oil and gas development could inhibit subsistence harvesters' use of traditional harvest areas, which could reduce harvest success; increase the cost, effort, and risk involved with subsistence harvest; increase the and wear and tear on equipment used for harvesting subsistence foods; devalue elders' knowledge of the traditional landscape; increase the importance of local knowledge of oil industry schedules and practices; and reduce the enjoyment of eating traditional foods, should harvests be reduced or perceptions of contamination of subsistence resources arise.

Conclusion

Under Alternative D, the duration, severity, and extent of the effects of oil and gas development activities on subsistence users and species would be greater than under Alternatives A and B, as there would be a larger area open for year-round occupation and development, which would include ecologically sensitive areas that would not be open under Alternatives A or B, which include caribou calving and insect relief areas, goose molting areas, and areas used by denning polar bears. The amount of habitat loss and degradation would also be greater under Alternative D than under Alternatives A and B. Oil and gas activities could divert caribou and waterfowl from normal habitat areas and deflect these species from normal migration routes until they were able to habituate to activities and infrastructure changes in these areas. Caribou might be deflected from preferred habitats at times of nutritional or energy stress. Development in the area around Teshekpuk Lake could reduce available areas for animals to use if set-aside areas are overgrazed or their value to the animals are reduced in response to climate, use, weather, drought or flood, and other possible forces which may change habitats. Increases in fox (red and Arctic), seagull, and jaeger populations associated with human activities could result in an increased risk for predation of molting geese, eggs, and fledglings. Changes in overwintering and seasonal fish habitat caused by oil development (e.g., turbidity, salinity changes, reduced dissolved oxygen, redirection of sheet flows, and possible spills) could harm fish populations. Some species, (e.g., wolves and wolverines) would avoid human activity, while others (e.g., bears and foxes) are attracted to such activity and could become nuisance animals. Oil and gas activities would inhibit subsistence users from harvesting in their traditional use areas, including areas previously unavailable for leasing. Polar bears may be affected in coastal and near-shore areas by seismic activities and development to a greater extent under Alternative D compared to Alternative A.

The opening of the area around Teshekpuk Lake could increase the amount of aircraft disturbance to subsistence species and users, as compared to Alternatives A and B. As discussed in **section 3.4.2, *Subsistence***, Nuiqsut, Barrow, Atqasuk, Wainwright and Anaktuvuk Pass depend on TLH caribou as a subsistence species. If oil and gas activities were to deflect, divert, or reduce the TLH caribou population, harvest of caribou by area residents could be reduced until the caribou were able to habituate to the increased activity and infrastructure in the area. Oil and gas activities in the northeast portion of the planning area could affect Nuiqsut subsistence and activities, deflecting migrating caribou away from traditional harvest locations, reducing harvest access and success. If TLH caribou were to move outside of their normal migration routes, Anaktuvuk Pass could suffer a shortage of caribou, its main subsistence resource, until the normal migration route was resumed. As a result, a greater expenditure and risk on the part of the subsistence hunters from Anaktuvuk Pass would be required, and other communities would supplement the loss of traditional foods at the cost of increased hunting effort and expenditure in their subsistence use areas. In the past, when the herd has failed to pass near the community, Anaktuvuk Pass hunters had to fly to other locations in search of subsistence food, increasing community stress and the time necessary for harvest success, as well as reducing the connection with traditional areas (SRBA 2003b).

Effects of Abandonment and Rehabilitation

During oil facility abandonment and rehabilitation activities, which include the removal of all equipment and facilities, and the plugging of all wells, subsistence resources and activities would be subject to impacts similar to those caused by construction as described under Alternative A (see **section 4.3.12.2**). Following the abandonment and rehabilitation, subsistence resources would be subject to fewer impacts. If the gravel roads and pads were left

in place and remained serviceable, they could be used by residents to provide access to subsistence resources, possibly reducing hunting effort and time.

Effects of Spills

Under Alternative D, it is assumed that 2.775 large spills (e.g., greater than or equal to 500 barrels of oil, but less than 120,000 barrels) consisting of an estimated 13,320 barrels of oil, could occur in the planning area. These spills would consist of unrefined crude oil from a pipeline, or possibly as much as 900 barrels of crude or diesel oil from a gravel pad facility. Small spills (e.g., less than 500 barrels) are currently the most frequently-occurring spill type on the North Slope, and primarily consist of the release of less than a barrel of aviation fuel, diesel fuel, engine lube oil, fuels oil, gasoline, grease, hydraulic oil, transformer oil and transmission oil. Under Alternative D it is estimated that a total of 659 small crude oil spills and 1,628 refined oil spills could occur in the planning area. A very-large spill, defined as a spill greater than or equal to 120,000 barrels of oil, is considered extremely unlikely to occur within the lifetime of this plan.

The risk of oil spills under Alternative D would be similar to that under Alternative A; however, a greater area of important caribou, waterfowl, and fish habitat would be subject to potential contamination by oil spills. The area surrounding Teshekpuk Lake and north to the Beaufort Sea, largely unavailable for leasing and/or year-round occupation under Alternative A and partially unavailable under Alternative B, would be open for year-round development and operation under Alternative D. Subsistence users have stated that they prefer not to hunt in industrial areas, and the communities of Barrow, Atqasuk, and Nuiqsut have harvested resources in the area to be opened under Alternative D. The communities of Barrow, Atqasuk, and Nuiqsut rely greatly on the TLH caribou for subsistence, and Wainwright and Anaktuvuk Pass utilize the herd to a lesser extent. Large oil spills could affect subsistence patterns by reducing populations of subsistence species, contaminating subsistence species or their habitats, resulting in the resource being unfit to eat or polluted. These effects could reduce the amount of subsistence foods harvested, cause changes in traditional diets, increase risks and wear and tear on equipment if users were required to travel farther to find more suitable resources, and cause social stress due to the reduction or loss of preferred foods harvested in the traditional fashion. Effects on subsistence harvest patterns would be greater under Alternative D than under Alternatives A and B, but less than under Alternative C, because oil and gas activity would occur over a larger and more ecologically sensitive area, and the likelihood of an oil spill occurring would be greater.

Commercial Gas Development

Effects on subsistence resources and harvest patterns from natural gas development and production under Alternative D would occur in much the same way as effects would occur under that alternative from oil development and production, though there would be no crude oil spills from gas production. Because Alternative D makes important subsistence resource habitat and subsistence use areas available for leasing and development, this alternative would likely result in greater impacts to subsistence than Alternative A, though less than Alternative C, which makes even more such area available. Winter burial of the pipeline would potentially disrupt caribou and subsistence hunters, though once buried, a gas pipeline should not have additional impacts on subsistence. If a natural gas well blowout occurred, the subsistence harvest of any species in the vicinity could be affected and, if an explosion and fire occurred, subsistence resources in the immediate vicinity could be killed. Natural gas and condensates that did not burn in the blowout would be hazardous to any organism exposed in high concentrations.

However, natural gas vapors and condensates would be dispersed very rapidly from the blowout site (1 km downwind for about 1 day) and would affect only those species in the immediate vicinity of the accident. While such an effect would be relatively short term and localized and likely would not measurably affect the regional population of any species, it could cause disruption to subsistence harvests in the area of the blowout. In addition, subsistence hunters, who already tend to avoid oil field infrastructure, may be even more likely to avoid gas fields for fear of a well blowout.

4.6.12.3 Effectiveness of Stipulations and Required Operating Procedures

The performance-based lease stipulations and ROPs are intended to protect subsistence resources to the same extent as the 1998 Northeast IAP/EIS ROD prescriptive lease stipulations under Alternative A. Under Alternative D, oil exploration and development would be allowed over a wider area and in more sensitive areas and habitats than under Alternative A; however, ROPs (e.g., ROPs H-1 and H-2) intended to minimize conflicts between subsistence uses and oil and gas activities would be in place. During scoping, subsistence users stated that the proposed revision to the 1998 Northeast IAP is a breach of faith, that opening up more areas in the planning area would have severe negative effects on subsistence users from Barrow and Nuiqsut, and that the BLM was acting as an advocate for development rather than managing the land for multiple compatible uses (Ahmaogak 2003, NSB 2004).

Local municipal government and tribal governments generally have few paid staff and limited funding, and local government officials and tribal leaders feel they are overtaxed when asked to provide meaningful input to BLM on permitted activities. Institutional overload affects subsistence users by placing increased, non-compensated demands on their time, further reducing the time available to continue subsistence pursuits and most severely for those working year-round, full time jobs. These officials and leaders contend that the change from the prescriptive lease stipulations in the 1998 Northeast IAP/EIS ROD to performance-based ROPs and lease stipulations in the Northwest IAP/EIS (and as proposed in this amendment) would place them in the position of having to defend subsistence interests because compliance is now defined in terms of meeting a management objective rather than meeting an absolute prescriptive standard. To effectively respond, they would have to further stretch their existing capabilities to review and comment on increasingly numerous industry proposals and their impact on subsistence (NSB 2004).

BLM holds that performance-based lease stipulations and ROPs would provide equivalent protection, while gaining flexibility for adaptive management. The flexibility of the new approach places greater reliance on on-going monitoring to insure that these procedures do in fact achieve equivalent protections. BLM is committed to directing the necessary resources to this on-going monitoring requirement, including support for the continuing work of the Subsistence Advisory Panel to provide oversight, exchange information, and develop solutions for any emerging issues.

Effectiveness of Stipulations and Required Operating Procedures on Subsistence Species

Under Alternative D, several ROPs and lease stipulations would address subsistence species. With the exception of Lease Stipulations K-4(h), K-9, K-10, and K-11, the ROPs and lease stipulations for Alternative D would be the same as for Alternatives B and C. Required Operating Procedures A-2 and A-8 would be effective in seeking to avoid human-caused changes in predator populations (i.e., avoid attracting wildlife to food and garbage). Required Operating

Procedures A-4 to A-7 would be effective in minimizing the impact of contaminants (spills) on wildlife and the environment and to protect subsistence resources. Required Operating Procedures B-1, B-2, D-1 and D-2 would be effective in maintaining populations of, and habitat for, fish and invertebrates.

Required Operating Procedure C-1 would be effective in protecting bear denning and birthing sites during overland moves. Required Operating Procedures C-2 to C-4 would be effective in protecting streams and prevent additional freeze down of deep-water pools harboring overwintering fish and invertebrates.

Required Operating Procedure E-1 would be effective in protecting subsistence use and access to traditional subsistence hunting and fishing areas and minimize the effects of oil and gas development on subsistence resources. Required Operating Procedures and Lease Stipulations E-2, E-3, E-6, and E-8 would be effective in maintaining free passage of marine and anadromous fish and protecting fish habitat, as well as subsistence use and access to traditional subsistence fishing. Required Operating Procedure E-7 would be effective in minimizing disruption of caribou movement and subsistence use by elevating pipelines to a minimum of 7 feet as opposed to the 5-foot minimum in the 1998 Northeast IAP/EIS ROD. Required Operating Procedure E-9 would be effective in minimizing human caused increases in populations of species that prey on ground nesting birds. Required Operating Procedure E-10 would be effective in preventing migrating waterfowl from striking oil and gas facilities during low-light conditions. Required Operating Procedure E-11 would be effective in minimizing the take of species listed under the Endangered Species Act (e.g., spectacled and Steller's eiders) and minimizing disturbance to other species caused by interaction with oil and gas facilities.

Required Operating Procedure F-1 would be effective in minimizing the effects of low-flying aircraft on wildlife. Lease Stipulations K-1 and K-2 would be effective in minimizing the disruption of natural flow patterns; changes to water quality; changes to floodplain and riparian areas; and loss of fish spawning, rearing, or overwintering habitat through setbacks along rivers and around lakes. Lease Stipulations K-3, K-5, K-6, and K-7 would be effective in protecting fish and wildlife habitat and minimizing disturbance of caribou and alteration of migration patterns in the Teshekpuk Lake region and in coastal areas.

Lease stipulations proposed under Alternative D would limit surface occupancy and disturbance while making 95% of the Northeast NPR-A available for leasing, exploration, and eventual production. Lease Stipulation K-4(h) would limit surface occupation in the Goose Molting Area north of Teshekpuk Lake to pipelines and allow winter seismic testing and exploratory drilling. Lease Stipulation K-9 would prohibit surface occupancy, excluding pipelines, in two areas: the first between the east shore of Teshekpuk Lake and the western extent of the Kogru River; and the second in an area northwest of Teshekpuk Lake, but would allow winter seismic exploration and exploratory drilling. Lease Stipulation K-10 would set aside the Southern Caribou Calving Area (located south and east of Teshekpuk Lake, and including the Kogru River) as a caribou calving, post-calving, and insect-relief area. No permanent facilities, except for pipelines, would be allowed in this area. Lease Stipulation K-11 would divide the area north of Teshekpuk Lake into seven large lease tracts. No more than 300 acres of surface disturbance would be allowed in each tract for permanent facilities, excluding pipelines. The limitations on surface area disturbance would be intended to reduce impacts to caribou and goose habitats. While these additional lease stipulations provide some protection for caribou and geese in areas opened for leasing under Alternative D, subsistence resources could still be affected by oil and gas activities, as pipelines would be allowed in all of the area opened up for leasing.

Effectiveness of Stipulations and Required Operating Procedures on Subsistence Harvest Patterns

In general, the ROPs and lease stipulations seek to protect specific resources by establishing spatial buffer zones around facilities and infrastructure, scheduling disruptive activities for periods when there is the least potential for conflicts with other users, making efforts to include community residents in project planning, monitoring effects on subsistence resources, and making efforts to minimize the interference of oil and gas exploration and development activities and structures with subsistence resources and users. The effectiveness of these measures depends heavily on their ongoing implementation, enforcement, and local participation. With the exception of Lease Stipulations K-4(h), K-9, K-10, and K-11, the ROPs and lease stipulations for Alternative D are the same as for alternatives B and C. Required Operating Procedure A-4 would be effective in minimizing the impact of contaminants (spills) on fish, wildlife, and the environment, and would protect subsistence activities and resources. Required Operating Procedure E-1 would be effective in protecting subsistence use and access to traditional subsistence hunting and fishing areas. Lease Stipulation E-3 would be effective in maintaining free passage of marine and anadromous fish and protect subsistence use and access to traditional subsistence hunting and fishing. Required Operating Procedure E-7 would be effective in minimizing the disruption of caribou movement and subsistence use by requiring that pipelines and roads be designed to allow the free movement of caribou and the safe and unimpeded passage of subsistence hunters. Ground pipelines would be elevated a minimum of 7 feet to facilitate wildlife passage and subsistence passage. Access, ramps would be placed, after consultation with appropriate Federal, state, and NSB regulatory and resource management agencies, in areas where facilities or terrain funnel caribou movement. Pipelines and roads would be separated by 500 feet, where possible.

Required Operating Procedure F-1 would be effective in minimizing the effects of low-flying aircraft on wildlife, traditional subsistence activities, and local communities. This ROP is designed to minimize aircraft disturbance of caribou and bird populations and sensitive habitat areas, especially near known subsistence camps and cabins or during sensitive subsistence hunting periods (spring goose hunting and fall caribou and moose hunting). Required Operating Procedures H-1 and H-2 are subsistence-specific mitigation procedures designed to provide opportunities for participation in planning and decision-making to prevent unreasonable conflicts between subsistence uses and oil and gas activities, including seismic exploration. Required Operating Procedure H-2 would define potentially affected cabins or campsites and would provide for additional consultation requirements for geophysical exploration beyond those required in ROP H-1. Required Operating Procedure I-1 would require the lessee to provide a cultural orientation program for all oil and gas workers to minimize cultural and resource conflicts with local inhabitants. Of special concern is aircraft use near traditional subsistence cabins and campsites during spring goose and fall caribou and moose hunting.

Lease Stipulations K-1 and K-2 would be effective in minimizing impacts to subsistence cabins and campsites and disruptions to subsistence activities by prohibiting permanent oil and gas facilities (e.g., gravel pads, roads and airstrips, and pipelines) through setbacks along/around the Colville, Ikpikpuk, Miguakiak, Kikiakrorak and Kogosukruk rivers, Fish and Judy creeks, and the Deep Water Lakes areas. Lease Stipulation K-3 would be effective in protecting subsistence resources and access to the Teshekpuk Lake area by ensuring that there would not be unreasonable conflicts with traditional subsistence uses and access or impacts to seasonally concentrated fish and wildlife resources. Lease Stipulation K-6 would be effective in minimizing impacts to subsistence activities in coastal areas through a setback of ¾ of a mile from the

coastline, to the extent practicable, as well as the use of previously occupied sites (e.g., Camp Lonely, various Husky/USGS drill sites and DEW-Line sites).

Alternative D has added lease stipulations regarding development in the Teshekpuk Lake Special Area as compared to alternatives B and C. Lease Stipulation K-4(h) allows for exploration in the Goose Molting Area, but allows for no permanent facilities, except for pipelines. This lease stipulation would limit impacts to sensitive geese during molting, nesting, and fledging periods. Pipelines affect the migration, grazing, insect-relief, and calving habitat use of caribou. Other animals, such as caribou, muskox, wolves, wolverines, moose, polar and brown bears, and Arctic and red fox, could be disturbed air traffic associated with monitoring pipelines and resupplying facilities, and pipeline-related habitat changes (McKendrick 2000). If wildlife were deflected or disturbed, subsistence harvest patterns could be affected as hunters would be required to travel further to harvest resources.

Lease Stipulation K-9 would close an area between Teshekpuk Lake and the Kogru River, and an area northwest Of Teshekpuk Lake to all surface occupancy, excluding pipelines, but would allow for winter exploration activities. This area is an important passageway for caribou migration, as well as for calving, post-calving and insect relief. Winter exploration activities such as seismic testing and exploratory drilling could disturb overwintering caribou, fish, wolves, wolverines, and denned brown bears. Caribou diverted from this area could be subject to increased harvest pressure if they escape oil exploration activity by walking towards Barrow, Nuiqsut, or Atqasuk. This lease stipulation would protect caribou calving, post-calving and insect-relief habitats, but could alter the distribution of caribou and make it more difficult for subsistence users to hunt caribou.

Lease Stipulation K-10 would designate 233,000 acres southeast and southwest of Teshekpuk Lake, and including the Kogru River, as Restricted Surface Occupancy for permanent facilities, but would allow for pipelines and for winter exploratory activities. This lease stipulation would reduce direct impacts to a key caribou calving, post-calving, and insect-relief area. Allowing pipelines through this area could divert or disturb caribou during critical calving and post-calving periods. Air traffic associated with pipeline monitoring could potentially disturb calving and post-calving caribou in the spring and summer and could disturb overwintering caribou. This lease stipulation would also reduce potential conflicts with subsistence users by limiting the amount of surface occupancy by permanent oil and gas facilities. By allowing pipelines in this area, however, use of the area by subsistence resource users could be impeded.

Lease Stipulation K-11 would divide the area north of Teshekpuk Lake into seven lease tracts. No more than 300 acres of additional disturbance would be allowed within each lease tract for permanent oil and gas facilities, excluding pipelines. Permanent oil and gas facilities and pipelines in this area could affect waterfowl, caribou, wolves and wolverines. Winter exploration, development and production activity in this area could divert or disturb overwintering caribou, wolves, wolverines, denned brown bears, and overwintering fish. Summer activity could divert or disturb waterfowl, caribou, fish, wolves, wolverines, brown bears, seals and walrus. Subsistence users from Barrow, Nuiqsut, and Atqasuk use the area for subsistence harvests in all seasons and may not use area if oil and gas development and production occurred in the area.

4.6.12.4 Conclusion

Most impacts to subsistence species associated with oil and gas development would be localized and would not substantially affect subsistence species numbers, as long as the activities

occurred outside of key habitat areas or migratory zones when animals were present. In addition, the ROPs and lease stipulations discussed above, could be effective in protecting subsistence species and may help to resolve conflicts between the oil and gas industry and local residents. Even in the best case scenario of species protection and consultation, however, subsistence users could be constrained by oil and gas facilities from harvesting subsistence resources, would question the health of those resources, and would tend to harvest resources at least 5 miles from areas of development. Should oil and gas exploration and development activities divert resources from their accustomed routes and places, greater effort would be required on the part of subsistence users to locate, access, and harvest sufficient quantities of these resources. Increased travel distances would result in greater expenditures for fuel and equipment, as wear and tear on snowmobiles, outboards, and four-wheel vehicles would occur. Impacts under this alternative would be expected to be greater than under Alternatives A and B, but less than Alternative C.

As expressed in public scoping testimony, local residents are fearful for the future of subsistence hunting on the North Slope, their ability to carry on with traditional customs and ways in their preferred locations without interference, and their ability to be able to pass along these traditions to their children. Under Alternative D, these fears could be realized if oil and gas development occurs in the area north of Teshekpuk Lake, and subsistence resources are impacted by these activities.

4.6.13 Sociocultural Systems

4.6.13.1 Activities Not Associated With Oil and Gas Exploration and Development

Under Alternative D, the effects of non-oil and gas activities on sociocultural patterns would be greater than under Alternative A, similar to Alternative B, and less than Alternative C. There would be a greater amount of scientific research and data collection undertaken prior to lease sales and as part of Federal land management responsibilities. These research efforts and associated aircraft use could cause temporary and localized diversion or deflection of subsistence species. It is not expected that the amount of recreational and solid and hazardous waste removal and remediation would be greater under Alternative D, but more overland moves could be required to support scientific and other activities in the areas newly available for leasing. Several families from Atqasuk, Barrow, and Nuiqsut use cabins, camps, caches, and other sites along the coast and inland to Teshekpuk Lake for subsistence activities. The area is also an important route for residents who travel by snowmobile between Barrow, Atqasuk, and Nuiqsut for social, subsistence, and employment reasons. Continued use of this area helps maintain family connections and a feeling of relatedness and stability, which could be impeded or reduced by increased activity if these areas are opened to oil and gas development. In general, effects from non-oil and gas activities under Alternative D would be temporary and localized, and would be unlikely to affect overall sociocultural patterns.

4.6.13.2 Oil and Gas Exploration and Development Activities

Oil and gas exploration, development, and production would require a seasonal network of ice roads, permanent gravel roads, runways, and pads, a year-round corridor for pipelines and powerlines, and permanent gravel pads and production facilities.

Effects of Disturbances

The types of effects on sociocultural patterns from disturbances caused by oil and gas activities under Alternative D would be the same as under Alternative A, but would be greater in intensity and duration. These impacts would be similar to Alternative B, but less than those expected under Alternative C. Increases in the amount of area available for leasing and exploration would have a corresponding increase in effects to subsistence harvests as compared to those for Alternative A. The development proposed for the planning area would require increased staging and overland travel during the winter, and in summer would require increased use of aircraft for supplies, equipment, and crew changes, as compared to Alternatives A and B. In all seasons, noise, lights, personnel, and traffic near oil and gas infrastructure could temporarily deflect or divert caribou in areas where activities are occurring; however, gravel pads could provide caribou with insect-relief habitat. These effects could change the distribution, timing, and location of the caribou harvest, which could require increased effort and expenditure on the part of subsistence hunters, resulting in sociocultural consequences, such as increased stress and a decreased sense of well-being. These problems are discussed in more detail in **section 4.6.19**. Oil and gas development could divert subsistence users from facilities at distances from 5 to more than 25 miles. Given the high gasoline costs on the North Slope, this would add additional cost to subsistence harvests. Increased fuel costs and wear and tear on hunters and their equipment would increase the need for wage labor to support subsistence pursuits and reduce the time available to pursue subsistence activities, which would result in sociocultural consequences, such as increased stress and a decreased sense of well-being. Increases in the speed, range, and reliability of outboards and snowmobiles have facilitated the mixed subsistence and wage economy, but could not compensate for impacts to subsistence harvest activities from continued development and production activities in important subsistence harvest areas as proposed under Alternative D.

As discussed under Alternative A, long-term change to sociocultural patterns would result from a weakening of stabilizing traditional institutions through prolonged stress and disruptive effects that could be exacerbated by activities occurring under this alternative. These changes are already occurring to some degree on the North Slope because of onshore oil and gas development, more dependence on a wage economy, higher levels of education, improved technology, improved housing and community facilities, improved infrastructures, increased presence of non-Natives, increased travel outside of the North Slope, and increasing penetration of television and the Internet. Data from other circumpolar Inuit populations suggest that continued modernization is associated with a trend toward displacement of sociocultural systems, including: a trend toward less time being spent conducting subsistence harvest activities; less subsistence consumption among younger generations; a greater focus on a cash-based economy, as opposed to the egalitarian sharing network; an increased importance on the nuclear family, as opposed to the more-traditional extended family structure (Curtis et al. 2005; Nobmann et al. 2005; Condon et al. 1995). North Slope Borough institutions, such as the school district that promotes the teaching of Iñupiat language and culture, the Arctic Eskimo Whaling Commission that negotiates with industry to protect Iñupiat subsistence whaling interests, the NSB Department of Wildlife Management, and other regional and village Native corporations and organizations, have been working vigorously and quite successfully at preventing the weakening of traditional Iñupiat cultural institutions and practices. Increased social interactions between oil-industry workers and Nuiqsut residents could be long term, but there is not expected to be a tendency toward displacement of Iñupiat social institutions. However, population changes in ethnicity, such as the influx of a large non-native population, could disrupt or displace existing sociocultural systems and cultural institutions. Small-scale changes in population and employment are unlikely to disrupt sociocultural systems or displace existing institutions (USDOI BLM and MMS 1998, 2003).

Effects of Abandonment and Rehabilitation

Abandonment and rehabilitation activities would restore habitat for caribou and other subsistence species and subsistence resources would be subject to fewer impacts, potentially improving subsistence opportunities. Abandonment and rehabilitation activities would likely provide jobs for local residents for several years. However, after oil and fields were reclaimed and abandoned, jobs associated with them would cease. At present, very few long-time Nuiqsut residents have jobs in the oil fields; people instead move to Nuiqsut if they get employment at the oil fields (CRA 2002). If local residents were to become substantially integrated into oil field operations and the local communities were to become dependent on revenues associated with their operation, the community would face a period of economic depression as fields were abandoned. The NSB is currently undergoing a period of contraction in services and funding as oil field revenues decline, and has had to cut police presence and privatize services in some rural communities (NSB 2000, Anchorage Daily News 2004). Other potential avenues for maintaining income at the standards established in the oil development era have not been identified.

Effects of Oil Spills

The effects of oil spills would be the same as those discussed in Alternative A. Under Alternative D there would be a greater likelihood that a spill event could occur than under Alternatives A and B, but less than under Alternative C, with the potential to damage unique critical habitats and subsistence use areas. Effects would vary in severity depending upon the timing and location of the spill event, but fish, waterfowl, and marine and terrestrial mammals could all be affected. An oil spill could result in contamination of subsistence resources and would be a threat to the health and lifestyle of the affected communities. If a large oil spill occurred in a traditional use area, then subsistence users would have to travel further to harvest uncontaminated resources, which would result in high effects to sociocultural patterns for a much longer time than the period that subsistence resources would be measurably contaminated. An oil spill that reached coastal waters could affect the harvest of marine mammals, including bowhead whale harvests, which are at the center of Iñupiat sociocultural organization.

Activities associated with cleanup of an oil spill could have an effect on sociocultural systems. In the event that a large spill contacted and extensively oiled habitats, the presence of hundreds of humans, boats, and aircraft would increase the displacement of subsistence species and alter or reduce access to subsistence species by subsistence hunters. These events would supply short-term employment for local residents, at the expense of long-term subsistence resource availability and long-term employment. Because it is expected that oil spills from activities would be small, chronic events and would normally be contained on the drill pad, effects from the spills themselves and potential disruptions from clean-up activities would be unlikely to cause excessive disturbance to sociocultural systems or the surrounding environment. A large oil spill, however, would be catastrophic to the sociocultural structure of the whaling peoples of the North Slope if it were to occur in a riverine, nearshore, or marine environment.

Commercial Gas Development

Effects on sociocultural systems under Alternative D and all other alternatives would be due to effects on subsistence harvest patterns, changes in employment and population, and effects on public health. In the event of natural gas development and production in the planning area, there could be an increase in employment and population in some North Slope communities and

subsistence use patterns and public health may be affected as described in **sections 4.6.12 and 4.6.19**, respectively. The amount of employment and population change would probably differ among the alternatives in rough proportion to the amount of oil production and infrastructure development that would occur under each alternative.

4.6.13.3 Effectiveness of Stipulations and Required Operating Procedures

The performance-based lease stipulations and ROPs proposed under Alternative D would provide equivalent or greater setbacks from rivers and lakes than under Alternative A, but would allow drilling, permanent facilities and pipelines in the area around Teshekpuk Lake. Exploration, including seismic testing and exploratory drilling, would also be allowed in the area around Teshekpuk Lake. Lease Stipulation K-11 would divide the area north of Teshekpuk Lake into seven lease tracts. No more than 300 acres of additional permanent oil and gas facilities, excluding pipelines, would be allowed within each tract.

Required Operating Procedure I-1 would require the lessee to provide a cultural orientation program for all oil and gas personnel involved in planning area activities in order to effectively minimize cultural and resource conflicts with local inhabitants. This orientation program, as it relates to subsistence pursuits and cultural concerns, would: 1) provide sufficient detail to notify personnel of applicable lease stipulations and ROPs, as well as inform them about specific types of environmental, social, traditional, and cultural concerns that relate to the region; (2) address the importance of not disturbing archaeological and biological resources and habitats, and provide guidance on how to avoid disturbance; 3) be designed to increase sensitivity and understanding of personnel to community values, customs, and lifestyles in areas where personnel would be operating; 4) include information about avoidance of conflicts with subsistence, commercial fishing activities, and pertinent mitigation; and 5) include information for aircraft personnel concerning subsistence activities and areas and seasons that are particularly sensitive to disturbance by low flying aircraft (e.g., aircraft use near traditional subsistence cabins and campsites, flights during spring goose hunting and fall moose hunting seasons, and flights near North Slope communities).

4.6.13.4 Conclusion

Under Alternative D, areas of importance to subsistence users, including areas surrounding subsistence camps, critical habitat for subsistence species, and large concentrations of historic and prehistoric cultural resources, could be impacted by oil and gas activities and could increase anxiety in Nuiqsut, Barrow, and Atqasuk. If oil and gas development occurs near the north shore of Teshekpuk Lake, and is connected by roads and pipelines to the Alpine field, an important subsistence use area used by residents of Nuiqsut, Barrow, and Atqasuk could be avoided by subsistence users. Bowhead whales would be deflected and their behavior made more dangerous to hunters if marine traffic increases in the Point Lonely area (NSB 2004). Development in the area north of Teshekpuk Lake could impact anadromous and amphidromous fish numbers, habitat, migration patterns, and quality as subsistence foods. Increased air and ground traffic could take place at the Alpine field and at a proposed staging area south of Nuiqsut, and could divert caribou and other subsistence species away from Nuiqsut. Increased traffic and activity could also make subsistence harvesting more difficult for residents who do not own or have access to motorized transportation or depend on walking, trucks, and OHVs to travel to harvest areas. Traffic that occurred north and south of Nuiqsut could isolate the community from subsistence resource harvest areas and could prevent residents from using their homelands, subsistence cabins and camps, and unspoiled open areas

for resource harvests and pursuits. This would further degrade the quality of life and connection of people with their land and environment.

Under Alternative D, economic impacts on the communities should be positive at the Borough level, but may not benefit local communities if the jobs and revenue generated in the communities do not offset the effects of loss of subsistence harvests and land use. Circumpolar Research Associates reported that long-time Nuiqsut residents did not get jobs in the oil field, rather, people were hired from other communities and moved to Nuiqsut after getting the jobs (CRA 2002). Sarah Kunaknana, a Nuiqsut elder, and others in the communities have noted a growing divide in the communities that originates in the uneven distribution of benefits and costs from oil and gas exploration and development (NSB 2004). Nuiqsut residents have been impacted by industrial activity near the community, but do not feel that they have received a proportional amount of impact funds or other compensation.

While Federal subsistence management responsibilities would remain unchanged under all alternatives, residents stated during scoping that the proposed lease stipulations and ROPs would be more permissive to lessees, would not sufficiently protect subsistence use areas or resources, and would diminish what local residents consider to be the BLM's responsibilities in supporting and maintaining subsistence uses in the planning area. In their view, BLM would be shifting the responsibilities for enforcing the lease stipulations and ROPs to other local, state, and Federal agencies (Ahmaogak 2003, Napageak 2003, NSB 2004). Under Alternative D, areas protected under the 1998 Northeast IAP/EIS ROD would be made available for oil and gas leasing and development. The possibility that important subsistence use areas would be developed, and thus placed off-limits to other land users, has caused increased anxiety for residents of Nuiqsut, Barrow, and Atqasuk. Residents noted during scoping for this amendment that the existing lease stipulations had not been in effect long enough to be adequately tested, and that the provisions of the 1998 Northeast IAP/EIS ROD have not prevented ConocoPhillips from applying for, and the BLM from considering, development in the Fish Creek Setback as part of the Alpine Satellite Development Plan.

Commenters on the amended Northeast IAP/EIS stated that the granting of exceptions to the lease stipulations and ROPs was a factor undermining the credibility of the proposed Amended IAP/EIS. The consultation period leading to the Northeast Amended IAP/EIS ROD, was noted by local residents as being a "rushed," with no power on the part of the communities to reject or veto any particular course of action (NSB 2004). Local residents felt that instead of being consulted, they were being "informed" by the BLM, which did not build confidence on the part of the communities, and reinforced their feelings of being powerless to oppose changes being imposed by outside agencies and industry (NSB 2004). As a result, some residents regarded any effort to participate in consultation or other management processes as futile. This can create a feedback loop of decreased participation, decreased interest in cooperation with agencies, and increased conflict between agencies, lessees, and local resident groups as evidenced in scoping transcripts for 30 years of hearings held on the North Slope. BLM initiates consultation by informing interested parties of the proposed action, and inviting said parties to participate in consultation, the nature of which is to be determined by mutual agreement. If informed parties have no issues and do not wish to participate in further discussions, that is their choice and consultation may be complete, although the BLM will continue to communicate and inform those entities initially contacted for consultation throughout the planning process.

The BLM perspective on the effectiveness of mitigation measures also differs from that of village residents. BLM believes that the proposed performance-based approach to protecting the environment using lease stipulations and ROPs provides the agency greater flexibility to

achieve the necessary protections to mitigate the potential impacts from oil and gas development in areas proposed to be opened to oil and gas activities under the action alternatives. The prescriptive approach adopted in the 1998 Northeast IAP/EIS ROD gained legitimacy and credibility through the extended consultation leading to the final decision. The new approach proposed for Alternative D is not well known or understood, and some local residents doubt that the new approach would provide equivalent protection. The flexibility of the new approach places greater reliance on on-going monitoring to insure that modified procedures do in fact achieve equivalent protections. Based on input from the local communities during public hearings on the Draft Amended IAP/EIS, BLM developed Lease Stipulations K-8 through K-11 for Alternative D to address community subsistence concerns.

4.6.14 Environmental Justice

4.6.14.1 Activities Not Associated With Oil and Gas Exploration and Development

The non-oil and gas activities likely to occur in the planning area would primarily be transitory in nature, of short duration, and highly localized. They could temporarily divert, deflect, or disturb subsistence species from their normal patterns. Non-oil and gas activities could alter the availability of subsistence species in traditional harvest areas, which could affect harvest patterns by requiring hunters to travel further in pursuit of resources. Increased travel distances would result in greater expenditures for fuel and equipment, and increased wear and tear on snowmobiles, outboards, and four-wheel vehicles and could result in a higher risk of accidents. Consequently, there could be an effect on the subsistence hunting activities of the local minority population as a result of non-oil and gas activities. Under Alternative D, these effects could be slightly greater than those described under Alternative A, but would still be minor, temporary, short term, and generally highly localized. As outlined in **section 4.6.19**, this could result in isolate problems of social pathology.

4.6.14.2 Oil and Gas Exploration and Development Activities

Effects of Disturbance

Under Alternative D, disturbances caused by oil and gas activities would be the same as those discussed under Alternative A, but their effects on subsistence would be increased in magnitude, extent, and duration. Areas that would be unavailable for year-round occupation and development under Alternative A would be available for lease and year-round surface occupation under Alternative D, and could be affected by oil and gas development. Exploration and development activity could last 50-60 years, followed by 2-5 years of abandonment activity. This time frame would likely represent the duration of effects for species unable to habituate to the oil and gas development activities. Public health effects relating to sociocultural and dietary change, as well as exposure to contaminants, could persist for considerably longer.

Alternative D could have long-term effects on several terrestrial mammal species. In particular, effects on caribou herds would likely be slightly greater than under Alternatives A and B, but less than C (see **section 4.6.9, *Mammals***). It is expected that effects on waterfowl harvested for subsistence would more frequent and more widespread than under Alternatives A and B, given the greater area available for petroleum leasing. Little or no effect on marine mammals would be expected from onshore activities under Alternative D, but noise and disturbance associated with offshore barge and vessel traffic could impact bowhead whale migration patterns. There are concerns that, depending on the particular activity and, especially, the

location of the activity, actions occurring under Alternative D, as under Alternative A, B and C, could cause local effects on fish populations. All of these effects would be experienced primarily by the subsistence dependent minority Iñupiat population.

Under Alternative D, the possibility of public health impacts would be substantially increased compared with the Alternative A. These impacts would occur primarily through restriction in subsistence; influx of large numbers of outside workers; new access routes to the community; sociocultural and economic change; altered employment; and contaminants. Diabetes, hypertension, and related metabolic disorders would be expected to increase as subsistence is curtailed or as sociocultural changes lead to alterations in dietary patterns. Given that Alternative D involves substantially more development in and near particularly sensitive habitat and hunting and fishing areas, the risk of dietary change and the resultant increases in metabolic disorders would appear to be significantly greater. Food insecurity would likely increase substantially, and hunger could increase as well is substantial impacts on subsistence harvests occur. Cancer, lung disease, endocrine disruption, and neurodevelopmental delay are related to contaminants common to oil and gas development. Because of both the increased total emissions projected under this Alternative, and the location of operations within an important subsistence area, the risks of these problems would be increased under Alternative D. Social pathology could result from the economic changes anticipated; from increasing access to drugs and alcohol; and from stress and maladaptive coping given the impacts to wider regions of important traditional use areas.

Effects of Abandonment and Rehabilitation

Activities associated with dismantling and removing of production pads and facilities could disproportionately impact Nuiqsut residents through disturbance, displacement, and mortality of subsistence resources, through subsistence users' avoidance of areas undergoing dismantlement and removal, and through potential impacts to water, air quality, and noise. Once abandonment and rehabilitation were completed, Nuiqsut residents would be disproportionately impacted by the reduction in local and Native corporation revenues and by fewer local jobs and business opportunities. Since economic depression is associated with increased social pathology, this could result in increases in domestic violence, injury, drug and alcohol problems, and suicide. Local residents could benefit from a reduction in impacts on subsistence resources, compared to during construction and operation.

Effects of Oil Spills

As discussed elsewhere, the magnitude of effects of a crude oil spill on subsistence resources would depend on the context of the spill, the volume and area covered by spilled product, and the amount of time the product was released before clean-up efforts commenced. Tundra oil spills could affect small numbers of terrestrial mammals and waterfowl unable to avoid the spill area, but would be unlikely to have population level effects. Oil spills (any size) directly into a water body, particularly in difficult to contain conditions such as breakup or broken ice, could spread widely and have effects on fish and waterfowl. In the nearshore environment, a large to very large spill, particularly during broken ice or storm conditions, could affect marine mammals including seals, and beluga and bowhead whales. Oil spills can also be associated with toxicological health effects in human populations, as outlined in **section 4.6.19**. Furthermore, if a large spill resulted in a substantial decrease in consumption of subsistence foods, food insecurity and hunger as well as diabetes and related metabolic disorders could increase.

The Iñupiat people consider contamination from oil spills in nearshore waters to be a catastrophic possibility that would threaten their very existence, primarily because of the potential effects of spills on bowhead whales, which are a very important part of their culture in addition to being a favored food source (Brower 1976, Itta 2001). Potential effects on subsistence harvest patterns would be greater under Alternative D than under Alternative A because oil and gas activity would potentially occur over a larger area in the planning area than under Alternative A, and there would thus be a greater potential for oil spills. Potential effects on harvest patterns would be less under Alternative D than under Alternative C, and slightly more than under Alternative B, because of the amount of area allowed for oil and gas activity. A major oil spill on the North Slope would result in effects that would impact Iñupiat subsistence users more than any other human group.

Commercial Gas Development

Environmental Justice impacts of gas development for Alternative D would be largely attributable to impacts to subsistence, sociocultural changes, and public health impacts and are described, respectively, in **sections 4.6.12, 4.6.13, and 4.6.19**. While impacts from an oil spill would not be a factor, it is possible that well blowouts or the fear of blowouts would increase subsistence users' avoidance of infrastructure. The proportional impacts among the alternatives would mirror that attributed to oil development.

4.6.14.3 Effectiveness of Stipulations and Required Operating Procedures

The lease stipulations and ROPs for Alternative D would protect subsistence resources to the same extent as the lease stipulations under Alternative A. Required Operating Procedures H-1 and H-2 would be highly effective in reducing conflicts between subsistence uses and oil and gas activities. Lease Stipulations K-4(h), K-9, K-10 and K-11, which are specific to Alternative D, would indirectly support subsistence use, and users, by abetting the caribou and waterfowl population successes.

4.6.14.4 Conclusion

Several lease sales have already taken place in the planning area. Exploration programs, consisting of seismic testing and drilling using ice pads, are ongoing. Residents of Barrow, Nuiqsut, and Atqasuk have noted some effects from these activities on subsistence (SRBA 2003a,b). One effect included the redistribution of caribou, wolves, and wolverines in response to seismic activity and cat trains operating in the NPR-A (SRBA 2003a, b). These effects would continue under Alternative D, and would be somewhat greater than under Alternatives A and B, but less than under Alternative C. Most effects of disturbance would still be short term, but the extent and magnitude would likely increase. Effects from oil spills would depend greatly on the size, location, and season of the spill. Small spills on gravel pads would have little or no environmental justice effects. A major spill into a watercourse, on the other hand, could have long term serious effects on Iñupiat subsistence activities. While any major spill would have serious consequences, the worst, from an environmental justice standpoint, would be one that occurred in a key harvest area or near a community, particularly Nuiqsut or areas used by Barrow residents in the northwest portion of the planning area.

The activities likely under Alternative D could also have substantial health effects, as outlined above and discussed in detail in **section 4.6.19**. Because the population within and near the planning area is primarily comprised of Iñupiat, any health effects that occur would disproportionately affect this minority population.

4.6.15 Coastal Zone Management

4.6.15.1 Activities Not Associated With Oil and Gas Exploration and Development

Under Alternative D, non-oil and gas activities would be subject to all applicable lease stipulations and ROPs, as well as any other Federal, state, or NSB regulations pertaining to the activities in question. These activities would be subject to permitting, and would include the activities noted in **section 4.2.1.1, *Activities Not Associated with Oil and Gas Exploration and Development***, and evaluated for Alternative A in **section 4.3.15.1, *Coastal Zone Management.*** As non-oil and gas activities are normal occurrences under existing BLM management practices, they would, in most cases, be of limited duration and magnitude, and effects on neighboring uses, primarily subsistence resources and harvest patterns of nearby communities, would be limited to the immediate area of the activity. Activities would be consistent with ACMP standards.

4.6.15.2 Oil and Gas Exploration and Development Activities

As described in **section 4.3.15, *Coastal Zone Management*** of this document, Section 307(c)(3)(B) of the CZMA requires applicants to certify that each of their activities that affects any land use or water use in the coastal zone complies with, and would be implemented consistent with, the state's coastal management program. In the following discussion, ACMP standards for uses and activities are used to evaluate activities and effects that would occur under Alternative D. Policies of the NSB CMP are assessed in conjunction with the most closely associated statewide standard.

This analysis is not a consistency determination pursuant to the Coastal Zone Management Act of 1972, as amended, nor should it be used as a local planning document.

Effects of Exploration and Development Related to the Alaska Coastal Management Program

Coastal Development (11 AAC 112.200)

Water dependency is a prime criterion for development along the shoreline. The intent of this policy is to ensure that onshore developments and activities that could be placed inland would not displace activities that depend on shoreline locations, which include marine shores, lakeshores, and river waterfronts. Under Alternative D, almost the entire Beaufort Sea coast within the planning area would be open to leasing, although Lease Stipulation K-11 would limit permanent surface disturbance to not more than 300 acres in each of seven coastal large lease tracts and Lease Stipulation K-4(h) would specify Restricted Surface Occupancy in much of the area between Teshekpuk Lake and the Beaufort Sea coast. Lease Stipulation K-6 would be highly effective in discouraging permanent oil and gas facilities within ¾ mile of the coast, and other ROPs and lease stipulations would address sensitive issues areas along parts of the coast and near deep-water lakes and major creeks and rivers.

Other lease stipulations and ROPs (See Table 2-2 in Chapter 2) in place under Alternative D would further reduce the potential for conflicts with this policy around lakes and rivers. Specifically, ROPs and lease stipulations related to waste-prevention, handling, and disposal and spills; ice roads and water use; facility design and construction; abandonment; protections

for subsistence and traditional use sites; and other activities restrictions would be effective in reducing conflicts, making Alternative D consistent with the statewide standard.

Natural Hazard Areas (11 AAC 112.210)

This statewide standard permits coastal districts and state agencies to identify and designate areas in which natural hazards are known to exist that may present a threat to life or property. Development in these areas would be prohibited until siting, design, and construction measures for minimizing property damage and protecting against the loss of life were provided.

Flooding, earthquakes, active faults, tsunamis, landslides, volcanoes, storm surges, ice formations, snow avalanches, erosion, permafrost, and beach processes in the planning area should be considered. Onshore development would be sited in areas of permafrost. Development in these areas would be required to maintain the natural permafrost insulation quality of existing soils and vegetation (NSB CMP 2.4.6[c] and NSBMC 19.70.050.L.3). Alternative D would be required to comply with the statewide standard.

Coastal Access (11 AAC 112.220)

Districts and state agencies shall ensure that projects maintain and, where appropriate, increase public access to, from, and along coastal water. Alternative D would be consistent with this standard, although the larger leasing area along the Beaufort Coast could lead to some conflicts with access opportunities, as compared to Alternative A.

Energy Facilities (11 AAC 112.230)

The ACMP requires that decisions on the siting and approval of energy-related facilities be based, to the extent practicable, on 16 criteria within the energy facilities standard. Lease stipulations and ROPs (See Table 2-2 in Chapter 2) in place under Alternative D would be effective in reducing conflicts, making the alternative consistent with the statewide standard.

Other criteria within this standard require that facilities be consolidated and sited in areas of least biological productivity, diversity, and vulnerability and where effluents and spills can be controlled or contained (11 AAC 112.230 (a) [3] and [14]). Under Alternative D, ROPs and lease stipulations would be effective in protecting biologically sensitive areas, although leasing would be permitted in coastal areas that would be off limits under Alternative A. The NSB CMP also requires that transportation facilities and utilities be consolidated to the maximum extent possible (NSB CMP 2.4.5.2[f] and NSBMC 19.70.050. K.6).

Construction associated with energy-related facilities under Alternative D would also be required to comply with siting standards that apply to all types of development, which are discussed below under Habitats; Air, Land, and Water Quality; and Historic, Prehistoric, and Archeological Resources.

Utility Routes and Facilities (11 AAC 112.240) and Transportation Routes and Facilities (11 AAC 112.280)

These statewide standards require that routes for transportation and utilities be compatible with district programs and sited inland from shorelines and beaches. Utility routes and facilities along the coast must avoid, minimize, or mitigate alterations in drainage patterns, disruption in wildlife transit, and blockage of existing or traditional access.

The NSB CMP contains several additional policies related to transportation and utilities that would be relevant to this analysis; all but one are best-effort policies and are subject to some flexibility. Transportation development, including pipelines, which significantly obstructs wildlife migration, is subject to three conditions (NSB CMP 2.4.5.1[g] and NSBMC 19.70.050.J.3.f). Interference with caribou movements would be temporary and brief under Alternative D, and would be specifically limited by Lease Stipulations K-9 and K-10; caribou migrations and overall distribution should not be greatly affected. Lease stipulations and ROPs in place under Alternative D would be effective in reducing conflicts, making the alternative consistent with the statewide standard.

Transportation facilities would be consolidated to the maximum extent practicable. Therefore, there should be no conflict with either NSB CMP 2.4.5.1(i) (NSBMC 19.70.050.J.3.h), which discourages duplicative transportation corridors from resource-extraction sites, or NSB CMP 2.4.5.2(f) (NSBMC 19.70.050.K.6), which requires consolidation of transportation facilities and utilities. Lease stipulations and ROPs required under Alternative D would be highly effective in reducing conflicts, making this alternative consistent with the statewide standard.

The NSB CMP 2.4.6(b) (NSBMC 19.70.050.L.2), under the category of Minimization of Negative Impacts, requires that alterations to water features associated with transportation and utilities be minimized, and that periods critical for fish migration be avoided. Lease Stipulation K-6, in particular, would be effective in ensuring compliance with this standard.

Sand and Gravel Extraction (11 AAC 112.260)

The ACMP statewide standards indicate sand and gravel may be extracted from coastal waters, intertidal areas, barrier islands, and spits if no practicable noncoastal alternative is available to meet the public need. Substantial alteration of shoreline dynamics is prohibited (NSB CMP 2.4.5.1[j] and NSBMC 19.70.050.J.3.i). Constraints may be placed on extraction activities to lessen environmental degradation of coastal lands and waters (NSB CMP 2.4.5.2[a] and [d] and NSBMC 19.70.050.K.1 and 4). Substantially more gravel could be required under Alternative D than under Alternative A, but ROPs and lease stipulations (See Table 2-2 in Chapter 2) would place restrictions on gravel mining locations and thus effectively reduce conflicts to ensure compliance with this standard and the NSB policies. Alternative D would require somewhat less gravel than Alternative B and substantially less than Alternative C.

Subsistence (11 AAC 112.270)

The statewide standard for subsistence indicates a project within a designated subsistence use area must avoid or minimize impacts to subsistence uses of coastal resources. Subsistence uses of coastal resources and maintenance of the subsistence way of life are primary concerns of the residents of the NSB. Under Alternative D, most of the Beaufort Sea coast would be open to leasing, albeit limited by constraints by ROPs and lease stipulations. As a consequence, access to subsistence resources could be more limited than under Alternative A. Disturbances and oil spills associated with oil and gas activities would have short-term and localized impacts on the TLH caribou and other terrestrial mammals, fish, birds, and bowhead whales and other marine mammals. The impacts would result in more difficult and somewhat reduced success at subsistence harvests for Barrow, Atqasuk, and Nuiqsut hunters. Subsistence-hunter concerns about access to resources, resource disturbance, and resource contamination would be greater than for the Alternative A, but less than for alternatives B and C. Lease stipulations (See Table 2-2 in Chapter 2) would offer protection to subsistence resources and activities. Surface, air, and

foot traffic near the oil fields would be expected to increase more than under Alternative A and would potentially displace larger numbers of caribou, moose, muskox, grizzly bears, wolves, and wolverines, but again to a lesser degree than under alternatives B and C. Roads and pipelines would be constructed to provide for unimpeded wildlife crossings. Based on the analysis of disturbance effects on caribou, potential conflict with the subsistence policies would be greater under Alternative D than under Alternative A, although Alternative D would likely still comply with the statewide standard.

Policy 2.4.3(d) (NSBMC 19.70.050.D) requires that development not preclude reasonable access to a subsistence resource. Onshore pipelines and construction activities could cause disruptions to subsistence caribou harvests from access and movement conflicts, but effects are expected to be short term. Where access is reduced or restricted, development can occur only if no feasible or prudent alternative is available, and is then subject to the conditions of best-effort policies. Conflict with these standards and policies would be somewhat greater under Alternative D than under Alternative A.

Several important NSB CMP policies relate to effects on subsistence resources. The NSB CMP Policy 2.4.3(a) (NSBMC 19.70.050.A) relates to extensive impacts to a subsistence resource that are likely and cannot be avoided or mitigated. In such an instance, development must not deplete subsistence resources below the subsistence needs of local residents of the NSB. Policy 2.4.5.1(a) (NSBMC 19.70.050.J.3.a) addresses development that would likely result in substantially decreased productivity of subsistence resources or their ecosystems. Temporary reductions in subsistence resources and changes in subsistence resource-distribution patterns could occur as a result of disturbance from seismic surveys, aircraft and vessel traffic, drilling activities, and construction activities.

The development scenario under Alternative D predicts that there would be an onshore pipeline for oil delivery to the TAPS and that a pipeline spill could potentially contaminate the Colville River. A spill entering the Colville River potentially could affect the subsistence harvest by reducing fish populations, disrupting subsistence-fishing activity, and curtailing the subsistence hunt by tainting resources or causing subsistence users to perceive them as tainted. However, the number and size of oil spills estimated for Alternative D would still be small. It is anticipated that the potential for effects from spills and associated clean-up activities would be greater under Alternative D than under Alternative A, but less than under alternatives B or C. The impact on subsistence resources and harvest patterns would remain minor.

Conflict with policies to protect subsistence resources would be possible during the exploration, development, and production phases. Under Alternative D, ROPs and lease stipulations designed to protect subsistence resources, and to establish procedures and advisory bodies to address subsistence concerns, would be effective in minimizing policy conflicts. Therefore, Alternative D should be consistent with the statewide standard.

Habitats (11 AAC 112.300)

The statewide standard for habitats contains management measures specific to nine areas: offshore areas; estuaries; wetlands; tideflats; rocky islands and seacliffs; barrier islands and lagoons; exposed high-energy coasts; rivers, streams, and lakes (including associated floodplains and riparian management areas); and important upland habitat. The NSB CMP contains a district policy that reiterates the applicability of the statewide standard (NSB CMP 2.4.5.2[g] and NSBMC 19.70.050.K.7), plus several others that augment the overall policy or can be related to activities within a specific habitat. Under Alternative D, fewer sensitive habitat areas

would be excluded from leasing than under Alternative A. However, applicable ROPs and lease stipulations, including four that are specific to this alternative, would provide effective protection for fish, birds, and terrestrial mammals, and their habitats (see Lease Stipulations K-4(h), K-9, K-10 and K-11. Therefore, conflicts with the ACMP standards would be minimized to the degree possible, making activities under Alternative D consistent with the statewide standard.

The ACMP statewide standard for habitats in the coastal zone requires that habitats be managed to avoid, minimize, or mitigate significant adverse impacts to habitat resources. This policy is supported by an NSB CMP policy requiring that development be located, designed, and maintained in a manner that prevents or minimizes impacts on fish and wildlife and their habitat, including water circulation and drainage patterns and coastal processes (NSB CMP 2.4.5.2[b] and NSBMC 19.70.050.K.2). In addition, vehicles, vessels, and aircraft that are likely to cause disturbance must avoid areas where species that are sensitive to noise or movement are concentrated, at times when such species are concentrated (NSB CMP 2.4.4[a] and NSBMC 19.70.050.I.1). Some disturbances associated with exploration and development would be mitigated by ROPs and lease stipulations placed on permits. Alternative D ROPs and lease stipulations (See Table 2-2 in Chapter 2) would be effective in reducing potential conflicts, and the activities would be consistent with the statewide standard.

Oil and gas development activities could affect several of the habitats identified in the statewide standard, including lagoons, wetlands, rivers, lakes, and streams. Therefore, onshore-development activities would need to be designed and constructed to avoid, minimize, or mitigate significant adverse effects.

It is expected that caribou of the CAH and TLH would be disturbed and their movements delayed along the pipeline during periods of aircraft overflights, but that disturbances would not affect migrations or overall distribution. It is expected that surface, air, and foot traffic near the oil fields would be greater under Alternative D than under Alternative A and could displace some large mammals, though not enough to substantially affect North Slope populations. The NSB CMP policy 2.4.6(e) (NSBMC 19.70.050.L.5) emphasizes that roads and pipelines must provide for unimpeded wildlife crossing and provides a set of guidelines and an intent statement specifically to implement the policy.

Rivers, lakes, and streams are managed to avoid, minimize, or mitigate significant adverse impacts to natural water flow, active floodplains, and natural vegetation within riparian management areas. Pipeline and road construction, including gravel extraction, could affect these waterways and would need to be conducted in a manner that would ensure the protection of riverine habitat and fish resources. Gravel extraction also is regulated under policies that are described in Section 11 AAC 112.260. The ROPs and lease stipulations in place under Alternative D would be effective in reducing conflicts, and would be consistent with the statewide standard.

Air, Land, and Water Quality (11 AAC 112.310)

The air, land, and water quality standard of the ACMP incorporates by reference all the statutes pertaining to, and regulations and procedures of, the ADEC. The NSB reiterates this standard in its district policies and emphasizes the need to comply with specific water and air quality regulations in several additional policies. North Slope Borough policies (NSB CMP 2.4.4[k] and NSBMC 19.70.050.I.11) address water quality issues, and development must comply with the conditions of the best-effort policies (NSB CMP 2.4.5.1[e] and NSBMC

19.70.050.J.3.d). Under Alternative D, there could be some short-term conflict with these policies due to potential oil spills, which would likely to be more frequent under Alternative D than under Alternative A, although less frequent than under alternatives B or C. However, the ROPs and lease stipulations (See Table 2-2 in Chapter 2) in place under Alternative D would be effective in reducing conflicts, and the alternative would be consistent with the statewide standards.

Some discharges and emissions would occur during exploration and development, and the NSB CMP policy 2.4.4(c) (NSBMC 19.70.050.I.3) requires that these emissions comply with all state and Federal regulations, which is consistent with the statewide standard.

Discharges of drilling muds, cuttings, and fluids are regulated closely. Formation water produced from the wells along with the oil is regulated by the USEPA. The Alaska Oil and Gas Conservation Commission has primacy for this program. Some wastes are disposed through the annulus of producing wells, an activity that is exempt from the Underground Injection Control program. However, the AOGCC also regulates this practice for the State of Alaska. Surface disposal of drilling wastes would require a solid waste permit from ADEC.

Because discharges of drilling muds, cuttings, and drilling fluids are closely regulated, no conflict is anticipated with the statewide standard or NSB CMP Policy 2.4.4(d) (NSBMC 19.70.050.I.4), which requires that industrial and commercial development be served by solid waste disposal facilities that meet state and Federal regulations. There would be no inherent conflict between the proposed activities of Alternative D and the ACMP water-quality provisions.

Air quality also must conform to Federal and state standards (11 AAC 112.310, NSB CMP 2.4.3[i] and 2.4.4[c], and NSBMC 19.70.050.H and I.3). The analysis of air quality effects under Alternative D in **section 4.6.1, *Air Quality*** indicates that conformance is anticipated, and no conflict between air quality and coastal policies should occur.

Historic, Prehistoric, and Archeological Resources (11 AAC 112.320)

The ACMP statewide standard requires that coastal districts and appropriate state agencies identify areas of the coast that are important to the study, understanding, or illustration of national, state, or local history or prehistory, including natural processes.

The NSB developed additional policies to ensure protection of its heritage. The NSB CMP 2.4.3(e) (NSBMC 19.70.050.E) requires that development that is likely to disturb cultural or historic sites listed on the National Register of Historic Places; sites eligible for inclusion in the National Register; or sites identified as important to the study, understanding, or illustration of national, state, or local history or prehistory shall 1) be required to avoid the sites, or 2) be required to consult with appropriate local, state and Federal agencies and survey and excavate the site prior to disturbance. The NSB CMP 2.4.3(g) (NSBMC 19.70.050.G) also requires that development not disturb newly discovered historic or cultural sites prior to archaeological investigation. It is likely that new cultural and paleontological sites would be discovered under Alternative D. No conflicts with these policies would be expected; however, ROPs and lease stipulations would be highly effective by requiring an inventory of traditional use sites prior to conducting any activities. Therefore, Alternative D would be consistent with the statewide standard.

Traditional activities at cultural or historic sites also are protected under the NSB CMP 2.4.3(f) (NSBMC 19.70.050.F) and 2.4.5.2(h) (NSBMC 19.70.050.K.8). As noted in the discussion of policies related to subsistence, the latter is a best-effort policy that requires protection for transportation to subsistence use areas as well as cultural use sites. No conflict with these policies would be expected.

Effects of Abandonment and Rehabilitation
Land ownership would not be affected by abandonment and rehabilitation. Upon completion of abandonment and rehabilitation, land uses and management could return to As near the original condition as practicable.

Effects of Spills

Because of the interrelated nature of the ACMP and NSB CMP policies, the potential effects of spills were addressed with the effects of disturbances under each major policy area above (See **section 4.2.2**).

4.6.15.3 Effectiveness of Stipulations and Required Operating Procedures

Lease stipulations and ROPs referred to under each of the Coastal Zone Policy standards discussed above would be sufficient for Alternative D to achieve compliance with ACMP and NSB CMP policies and standards. While it is expected that there could be land use and CZMP conflicts over the life of the alternative development scenario, any such conflicts should be short term and subject to resolution. Conflicts, should they occur, would most likely result from oil and gas development activities interrupting subsistence activities, but the scale of development and enforcement of applicable lease stipulations and ROPs should be effective in minimizing the conflicts and quickly returning the development to compliance with policies and standards.

4.6.15.4 Conclusion

It is expected that disturbance and oil spills associated with oil and gas activities would cause short-term and localized impacts to the TLH caribou and other terrestrial fish, birds, mammals, and bowhead whales and other marine mammals. In general, impacts to subsistence and other coastal zone resources from non-oil and gas activities, and from exploration and development activities, would be additive, except where these activities occurred in areas previously disturbed during exploration or development.

These impacts would likely be greater under Alternative D than under Alternative A, as would subsistence-hunter concerns about access to resources and resource contamination. The greater degree of impacts would result from opening additional area to leasing in caribou, waterfowl, and fishing areas, and because the expected level of development would be greater. The impacts would be less under Alternative D than under alternatives B or C, however. Conflicts with ACMP and NSB CMP policies related to effects on subsistence resources resulting from periodic disturbance and oil spills would be possible, but no resource would become unavailable, undesirable for use, or experience overall population reductions. Implementation of ROPs and lease stipulations would effectively ensure that Alternative D would comply with ACMP standards. Combined oversight by BLM, the ADNR, and the NSB, under the guidance of their respective standards, would be sufficient to deal with any potential conflict that could arise between Alternative D and the policies addressed in this section.

4.6.16 Recreational Resources

4.6.16.1 Activities Not Associated With Oil and Gas Exploration and Development

Under Alternative D, impacts to recreation resources from on-the-ground management activities such as archeological collection efforts, field camps, survey work, and overland moves would be very similar to recreation effects from Alternative A. The level of non oil and gas activity may increase under this Alternative as compared to Alternative A, as a result of a general increased interest in the area generated by the potential for more oil and gas.

Temporary structures, vehicles, noise from generators, aircraft, human presence, and associated activity all would have some minimal short-term effects on the experience of solitude, naturalness, or primitive/unconfined recreation. As under Alternative A, the short-term impacts from Alternative D would be confined primarily to the activity site viewshed or noiseshed within approximately ½ mile in any direction of the activity (500 acres). All of the identified non-oil and gas activities would be transitory and short term; the likelihood of recreationists encountering them in any given location in the 4.6 million acre planning area would be small. If such activities were encountered, the recreation experience and opportunity for solitude on the North Slope would be diminished. Depending on the activity, there may be some increased likelihood of an encounter with recreationists because of the propensity to concentrate on major rivers and coastal areas.

A longer-lasting impact would be trails resulting from overland moves. These trails do not necessarily develop over the entire route of an overland move, but when they do they can be very detectable from the air for 2 to 5 years. They are typically more difficult to recognize from the ground. Vegetation can also be damaged along these trails from broken stems or the tops of tussocks being scraped off. Current operating procedures make this an infrequent problem but one that can occur in conjunction with trails. Because overland moves would be relatively constant from year to year and generally follow the same route(s), several thousand miles of intermittent trail in some phase of recovery would likely be visible from the air during any one summer season. Though still relatively short term in nature, the linear nature of these trails would emphasize the presence of man, which would reduce the sense of naturalness and unconfined primitiveness to a small degree.

Although there are no formal designations of wilderness or wild and scenic rivers in the planning area, and none are anticipated at this time, none of the identified non-oil and gas activities would diminish requisite wilderness and wild and scenic river characteristics sufficiently to preclude such designations in the future.

4.6.16.2 Oil and Gas Exploration and Development Activities

Effects of Exploration

Under Alternative D, seismic work would occur throughout most of the planning area. This work would occur in winter using all-terrain ground vehicles supported by light aircraft. Mobile seismic camps would consist of a train of trailer sleds pulled by tractors. These moving camps and associated noise and activities would result in a short-term effect on the primitive setting of the planning area and a loss of solitude and naturalness. The effects would be confined primarily to the activity site viewshed or noiseshed, or within approximately ½ mile in any direction. As many as five seismic operations could take place in a season, temporarily affecting

approximately 2,500 acres. The potential effect on recreation opportunities and experience would be minimized by the fact that very little recreation takes place in the area.

A longer lasting impact would be trails resulting from seismic survey operations. Unlike overland moves, seismic operations do not follow the same routes every year and the number of miles of survey line run can vary greatly from year to year. In some years, no surveys would occur. As with trails created by overland moves, these trails do not necessarily develop over the entire survey route; they would be visible for about 2 to 5 years. Because of the many variables involved, it is difficult to make a reliable estimate as to the number of miles of trail that would be visible during anyone summer season as a result of seismic operations. However, oil and gas scenarios state that approximately 250 miles (6,060 acres) of line would be surveyed using 2-D seismic methods, while approximately 10,560 miles (98,880 acres) of line could be surveyed annually using 3-D seismic methods, potentially resulting in several thousand miles of trails. Mobile camp trails could add another 840 miles (3,056 acres) of trails. Although some of the camp train route could be outside of the planning area and could overlap survey line miles. The number of miles of trail visible would decline as this phase of exploration slows.

Approximately 193 exploration and delineation wells would be drilled under Alternative D. However, due to the limited number of drill rigs available, it is anticipated that no more than seven wells would be drilled at any one time. Drilling would primarily occur over several winter seasons using ice pads, roads, and airstrips. Temporary on-site location of structures (e.g., drill rigs); noise from generators, vehicles, and aircraft; human presence; and associated activity all would have short-term impacts on solitude, naturalness, and primitive/unconfined recreation experiences. These impacts would be expected to be greatest within a 2-mile radius of the drill site, which is an area of approximately 8,000 acres per well site. Accordingly, under this alternative, there would be a temporary loss of solitude, naturalness, or primitive/unconfined recreation over an area of approximately 56,000 acres. This would be equivalent to about 1.2% of the planning area and the potential effect on recreation opportunities and experience would be further minimized by the fact that most drilling occurs during winter when very little recreation takes place in the area.

In addition to the short-term impacts that result from ongoing exploratory drilling operations, an accumulating summer-season visual concern exists as a result of the "greening" of vegetation under vacated ice pads, airstrips, and roads. This direct impact to the area's naturalness would be a result of the same conditions that create "green trails", the greater availability of moisture and nutrients as ice or compacted snow melts. This "greening" of the vegetation does not necessarily develop wherever ice pads are constructed or snow is compacted but when it does, it can be very noticeable from the air for 2 to 5 years and somewhat less noticeable from the ground. Another impact at these sites would be vegetation actually being damaged or broken, especially along the perimeter of a pad or edge of a road. Exploratory drilling operations and ancilliary facilities i.e. 193 ice pads (6 acres each), 30 airstrips (11 acres each) and 6,162 miles of ice roads (3 acres/mile) would result in as many as 19,974 acres that would be in a various state of recovery from these impacts.

Exploration wells that do not indicate the presence of hydrocarbons in developable quantities will be plugged and abandoned leaving nothing more than possibly a mound of dirt expected to be no larger than a square foot on the lands surface. Wells that show potential may be "suspended," and capped with what is known as a "Christmas tree" at the surface, especially if the well might be used again for possible oil production. These are essentially permanent impacts (less than 6 feet high), but almost unnoticeable from several hundred feet away.

Effects of Development

Up to 32 production pads, and 162 miles of pipeline that extend beyond the production area, are anticipated under Alternative D. While the intensity of impacts would be greatest during actual construction and development of these facilities, remaining structures, human presence, and associated activity and noise all would have impacts on the experience of solitude, naturalness, and primitive/unconfined recreation opportunity during the life of the field. Because production could occur for 10-50 years beyond the development phase, impacts would be long term. These long-term impacts are expected to be greatest within 2 miles of a pad or staging area site (or an area of about 8,000 acres).

Pipelines also would impact recreation values. Pipelines would be elevated a minimum of 7 feet above the ground surface. There would be little if any pipeline associated on-the-ground activity, except during construction and repair. Long-term impacts to recreation values from pipelines would be expected to be minimal beyond about ½ mile. This equates to about 640 acres per mile of pipeline. Impacts to recreation values from a staging base would be similar to those resulting from a production pad and its facilities, or about 8,000 acres impacted per staging base. Accordingly under this alternative, there would be a long-term loss of solitude, naturalness, or primitive/unconfined recreation opportunity over an area of 359,680 acres (i.e., [8,000 acres/pad x 32 pads] + [640 acres/mile x 162 miles of pipeline]). In addition, it is estimated that long-term surface (i.e. 2 miles from footprint of staging and CPFs) disturbance and consequently impacts to primitive recreation from three staging areas (50 acres each) and six CPFs (90 acres each) including pads, roads, airstrips, gravel pits, and infield gathering pipelines and associated infield gravel roads (320 miles) would impact 290,900 acres (i.e. [9,300 acres/staging area x 3 staging areas] + [9,700 acres/CPF x 6 CPFs] + [640 acres/mile of road x 320 miles]). These impacts combined (650,580 acres), would be equivalent to about 14.1% of the planning area. Short-term, routine/daily inspection flights also would impact solitude and naturalness along the length of all pipelines as long as they are in use. The potential effect on recreation opportunities and experience would be greatest for development activities because it would entail year-round activity and would thus continue during the summer when most recreational activity in the planning area occurs. Therefore, the effects to recreation use would not be considered a great impact, because they would impact such a small portion of the planning area (14.1%) and because there is such a small amount of recreation use in the area. The actual effects would depend greatly on where development fields were located relative to major watercourses and the Beaufort Sea coast. The area subject to recreation effects from development under Alternative D would be approximately 116,600 acres greater than that affected under Alternative A.

Effects of Abandonment and Rehabilitation

While abandonment and rehabilitation activities occurred, small number of recreational users in the area of rehabilitation could have their wilderness experience diminished by noise, marred views, and disturbance to animals which they have come to observe (bird-watchers) or harvest (hunters). However, over the long term, these efforts would minimize and impacts to recreation use would likewise be minimized.

Effects of Spills

Most spills would be confined to a pad. Spills not confined to a pad usually are confined to the area immediately around the pad or pipeline. Therefore, effects on solitude, naturalness, or

primitive and unconfined recreation opportunities resulting from spills likely would be confined to the same area described above as impacted by the development.

A large spill that could reach a river, especially the Colville River, and move rapidly downstream would have substantial short-term (and possibly long-term) impacts on recreation values.

Effects to Wilderness and Wild and Scenic River Values

None of the identified non-oil and gas activities would diminish requisite characteristics sufficiently to preclude wilderness or wild and scenic river designations in the future.

Potential wilderness values of naturalness and outstanding opportunities for solitude and primitive, unconfined recreation experiences would be affected by long-term development of petroleum resources on as much as 14.1% of the planning area under Alternative D, about 1% greater than the area that would be similarly affected under Alternative A. In addition, there could be portions of the area that were explored unsuccessfully that would experience lesser residual effects that would reduce wilderness values. Despite the lost values, over 3.9 million acres (86%) of the planning area would likely retain substantial wilderness values. For perspective, the Wilderness Act specifies a minimum of 5,000 acres to qualify for wilderness consideration in most cases.

The "outstandingly remarkable values" that support Wild and Scenic River eligibility for the Colville River include recreation, wildlife viewing, geology and archeology upstream from Umiat, and paleontology and wildlife from Umiat to Nuiqsut. Only a small portion of the Colville River would experience effects to these values from activities associated with Alternative D, primarily from an expected pipeline crossing of the river in an as yet undetermined location. Specified buffer areas would provide substantial protection for the Colville and other rivers, except in the area very near the pipeline crossing. Although pipeline crossings are discouraged in designated Wild and Scenic River areas, they are permissible, when unavoidable, if measures to minimize effects on the river's outstandingly remarkable values are utilized.

Wild and Scenic River designation is not planned or proposed for the Colville River, as noted in **section 3.4.6.3**, but the applicable lease stipulations and ROPs would preserve most, if not all, of the character and values that could qualify the river for designation in the future, if local and state political sentiments should ever determine designation to be favorable. A potential pipeline would not disrupt the requisite "free flowing" nature of the river and, to the degree possible, it would be sited to avoid the areas specific to the "outstandingly remarkable values" noted above. Selection of a river crossing location for the pipeline would require a permit from the BLM, which would afford an opportunity for more detailed review of effects on the Wild and Scenic River eligibility of the Colville River.

Commercial Gas Development

Because a gas pipeline would likely be buried and because little recreation occurs in the planning area in the winter when construction would primarily occur, there would be very little impact to recreation from gas development. The exception might be if gas development prompted some development that would not occur if only oil could be developed. In those cases, impacts would be similar to those associated with oil development. Given the different amounts of development considered likely under the various alternatives, it is likely that gas

development under Alternative D would create less impacts than Alternative C, but more than Alternatives A and B.

4.6.16.3 Effectiveness of Stipulations and Required Operating Procedures

Although the lease stipulations and ROPs do not specifically address recreation activities and there is no current intention to consider designation of wilderness or wild and scenic rivers in the planning area, many of the performance-based lease stipulations and ROPs required for development of Alternative D would serve to protect recreation values in the area. For example, areas excluded from leasing and several ROPs and lease stipulations address protection of subsistence values and wildlife in the planning area. Also, buffer requirements serve to minimize potentially damaging activity in and near creeks, rivers and lakes. Since wildlife viewing, big game hunting and boating are major factors attracting recreationists to the planning area, these lease stipulations and ROPs associated with Alternative D also serve to protect and preserve recreation values.

4.6.16.4 Conclusion

There would be approximately 2,000 to 3,000 acres in temporary effects on recreation values from activities other than oil and gas exploration and development. Short-term (temporary) disturbance from ongoing oil and gas exploration activities would impact approximately 107,996 acres. The "greening" of vegetation resulting from ice pads, roads, airstrips, and compacted snow would impact an additional 19,974 acres. Most of the combined 127,970 acres could be in a various state of recovery from the "greening" effect. Seismic operations would result in temporary impacts to recreation use over many hundreds of miles of trails and noise and other disturbance produced by seismic operations. Short-term impacts such as trails and pads, disturbance from noise, aircraft and other on-going activities would not accumulate.

Oil and gas development would result in the long-term loss of solitude, naturalness, or primitive/unconfined recreation opportunities over an area of approximately 650,580 acres (or 14.1% of the planning area) for the life of production fields and pipelines. The area subject to recreation impacts would be very similar to the impacts on recreation under Alternative A. Lease stipulations to mitigate for these impacts would be similar for both alternatives.

4.6.17 Visual Resources

4.6.17.1 Activities Not Associated with Oil and Gas Exploration and Development

Under Alternative D, impacts to visual resources would result from on-the-ground management activities, such as archaeological collection efforts, field camps, survey work, overland movements, and hazardous and solid material removal and remediation activities and would be similar to Alternative A. The level of non oil and gas activity may increase under this alternative, as a result of general increased interest in the area generated by the potential for more oil and gas development.

Temporary structures (e.g., sleds, tents), vehicles (e.g., Rolligons, tractors), aircraft, human presence, and associated activities would have some minimal short-term impacts on visual resources or scenic quality by creating a contrast to the line, color, and texture of a primarily horizontal natural landscape. The colors of structures and equipment would contrast the white

color of the snow-covered landscape and the various hues of greens and browns, and the smooth texture of the facilities would contrast the varied textures of the windswept terrain and the irregular texture of vegetation. Non-oil and gas activities would need to occur within the Foreground-Middleground Zone of the viewshed in order to attract the attention of the casual observer.

A longer-lasting impact would be trails, sometimes referred to as "green trails," resulting from winter overland moves. Between 20 and 60 trains comprised of one to six vehicles and attached sleds could engage in overland travel each year. These trails form when vehicles compact snow and dead vegetative material, resulting in a greater availability of moisture and nutrients for underlying vegetation the following growing season. Visible trails would not necessarily develop over the entire route of the overland move. Vegetation could be damaged along these trails and the tops of tussocks could be scraped off, although current operating procedures would ensure that such damage was an infrequent problem. Trails would be visible for about 2 to 5 years, but some trails may be visible for longer periods of time. However, because they visually modify existing vegetation, rather than adding something foreign into the viewshed, trails would not produce much contrast to line, form, or texture. The color contrast would be minimal from ground view because of the natural variation in hue, and would be almost nonexistent from more that a few hundred feet away.

4.6.17.2 Oil and Gas Exploration and Development Activities

Effects of Exploration

Under Alternative D, impacts to visual resources from seismic surveys would be the same as Alternative A. The discussion is repeated here for convenience.

Five seismic surveys would occur. Seismic work would occur in the winter using cat trains with low-ground-pressure vehicles supported by light aircraft. Seismic crews would be housed in mobile camps consisting of a train of trailer sleds pulled by tractors along different trails. These moving camps and associated activities would result in short-term impacts on visual resources and the scenic quality of the area by creating color contrast between the vehicles and trailers and the predominantly white background of the snow-covered landscape. These impacts would be confined primarily to the activity-site viewshed.

Trails resulting from seismic survey operations would result in a longer-lasting impact to visual resources. Unlike overland moves, seismic operations would not follow the same routes every year, and the number of miles of survey line could vary greatly from year to year. In some years, no surveys would occur. Like trails caused by overland moves, trails caused by seismic operations would not necessarily develop over the entire survey route, but where present would be visible for about 2 to 5 years, but some trails may be visible for longer periods of time. Approximately 250 miles (6,060 acres) of lines would be surveyed using 2-D seismic surveys, while approximately 10,560 miles (98,880 acres) of lines could be surveyed during each 3-D seismic survey, potentially resulting in several thousand miles of green trails. Mobile camp trails could add another 840 miles (3,056 acres) of green trails. Because trails visually modify existing vegetation, they would not produce much contrast to line, form, or texture. The color contrast would be minimal from ground view because of the natural variation in hue, and would be almost nonexistent from more than a few hundred feet away.

Approximately 193 exploration and delineation wells would be drilled under this alternative, 42 more than Alternative A, 23 more than under Alternative B, but 17 less than Alternative C.

Given the limited number of drilling rigs available, however, no more than seven drilling rigs would likely be operating at any one time. Drill rigs (average height of 208 feet) would introduce strong vertical lines into a predominantly horizontal landscape. Because they are painted red, most drill rigs would also produce a strong visual contrast to the white background of the snow covered landscape. Winter drilling requires lighting, which would create a visual contrast against the dark night sky. Drill rigs, because of their height, could be seen and attract the attention of the casual observer if they were located within the Foreground-Middleground Zone and Background Zone.

In addition to the impacts that would result from ongoing exploratory drilling operations, the greening of vegetation under vacated ice pads, ice airstrips, and ice roads would cause impacts to visual resources during the summer. This greening of vegetation would be caused by the same conditions that create "green trails" — a greater availability of moisture and nutrients as ice or compacted snow melts. However, greening of vegetation would not necessarily occur everywhere ice facilities were constructed or snow was compacted. There would also be a "ring effect" around ice pads, ice airstrips, and ice roads caused by the death of vegetation adjacent to these snow and ice structures. Winter facilities inclusive of 193 ice pads (6 acres each), 30 airstrips (11 acres each), and 6,162 miles of ice roads (3 acres per mile) would result in as many as 20,202 acres that would be in various states of recovery from greening and ring effects under Alternative D (16,768 acres in Alternative A; 20,022 acres in Alternative B; and 23,463 acres in Alternative C). Because greening and ring effects visually modify existing vegetation, they would not produce much contrast to line, form, or texture. The color contrast would be minimal from ground view because of the natural variation in hue, and would be almost nonexistent from more that a few hundred feet away.

Dry exploration wells would be cut off and plugged below ground level and temporally leave only a small area barren of vegetation while exploration wells with production potential would leave behind a marker pipe (also known as a Christmas tree), which would likely be less than 6 feet tall and no larger than a square foot on the surface. This marker pipe would essentially be a permanent impact, but would be almost unnoticeable from a distance of several hundred feet.

Effects of Development

Production rigs (two with an average height of 208 feet) would introduce strong vertical lines into a predominantly horizontal landscape. Because they are painted red, most drill rigs would also introduce strong contrast to the natural browns landforms and greens of the vegetation. In addition, burn-off flares and general work lighting would contrast against the dark night sky. Drill rigs, because of their height and color, could be seen and dominate the attention of the casual observer if they were located within the Foreground-Middleground Zone and Background Zone.

It is estimated that long-term surface disturbance from three staging bases (50 acres each), six pump stations (20 acres each) and six CPFs (90 acres each) would impact 810 acres (650 acres in Alternative A; 810 acres in Alternative B; and 970 acres in Alternative C). These facilities would introduce strong vertical lines from buildings into the landscape of predominately soft horizontal lines. There would also be a visual contrast between the simple, regular form of the buildings and the complex, irregular forms of the vegetation. Colors of buildings and materials would be in contrast with the greens, browns, and blues of vegetation and water bodies. Some of the buildings could be up to three stories in height above the tundra, and would attract and dominate the view of the casual observer if located within the Foreground-Middleground Zone.

Production pads (32 at 10 acres each),320 mile of infield roads (2,480 acres), six airstrips (11 acres each), 14 gravel pits (50 acres each), and 320 miles of infield gathering pipelines (972 acres) would impact 4,538 acres (2,818 acres in Alternative A; 3,664 acres in Alternative B; and 4,649 acres in Alternative C). The gravel pads, airstrips and infield roads would generally be only 3 to 5 feet above the surrounding green tundra, and would be relatively unnoticeable beyond a few thousand feet. Infield gathering pipelines (4-10 inches in diameter) would introduce shiny and smooth horizontal lines into a natural landscape. They would also introduce regularly spaced vertical supports into an irregular horizontal landscape, but would be associated with other facilities within the disturbance area. Disturbance associated with gravel sites from borrow pits or below ground bedrock would generally occur below the ground surface, with only stockpiled materials being visible above ground. While these sites could be large in size or footprint, very little material would remain as stockpile at any one time. Gravel mine sites from above ground bedrock locations may produce visible impacts if material is removed from rock outcrops within the planning area. This mining activity would change the form of the natural landscape and may be visible from the Foreground-Middleground Zone.

It is anticipated that as many as 162 miles of sales oil and main pipelines impacting up to 491 acres (3 acres per mile), would be constructed under Alternative D (162 miles, 491 acres in Alternative A; 162 miles,491 acres in Alternative B; and 182 miles, 551 acres in Alternative C). There would be no on-the-ground activities associated with sales oil and main pipelines, except during construction and repair. Sales oil and main pipelines (12-20 inches diameter) would introduce shiny and smooth horizontal lines into the naturally irregular brown and green landscape. They would also introduce regularly spaced vertical supports into an irregular horizontal landscape. All pipelines would be elevated at least seven feet above the surrounding tundra, but could be elevated as high as 20 feet above ground level. At these elevations, pipelines would attract and dominate the attention of the casual observer if located within the Foreground-Middleground Zone and Background Zone.

Other facilities associated with development would include bridges and communications towers. If located within the Foreground-Middleground Zone, bridges, because of their contrast with smooth water bodies, and communications towers, because of vertical height above the horizon, would be likely to attract the attention of a casual observer.

Vehicle traffic on roads during construction and other production activities would create short-term noticeable visual impacts through the creation of dust. Summer vehicle travel off gravel pads and roads would be very limited, but may cause color changes from the natural landscape by causing damage to vegetation and possibly the tundra mat. These changes would be limited to the Foreground-Middleground Zone.

Effects of Abandonment and Rehabilitation

During abandonment and rehabilitation activities, vehicle traffic on roads would create short-term noticeable visual impacts through the creation of dust. Gravel pads and roads may or may not be removed and may or may not be revegetated with native species or other appropriate vegetative materials. Once closure and abandonment activities including revegetation are completed, the strong contrasts with the surrounding vegetation colors created by structures, such as pipelines and buildings, gravel pads, roads and airstrips would be eliminated. If gravel is not removed and not revegetated, long-term color contrasts would remain between the gravel areas and the surrounding natural vegetation.

Effects of Spills

Most small spills would be confined to a pad. Small spills not confined to a pad would usually be confined to the limited area immediately around the pad or pipeline, and usually impact less than five acres. With proper containment and clean-up, there would be no new visual impacts associated with small spills estimated to occur 2,287 times over the life of oil and gas activities in the planning area under this alternative (1,792 in Alternative A; 2,070 in Alternative B; and 2,503 in Alternative C).

Large spills, estimated to occur about three times during the life of oil and gas activities in the planning area, would likely reach beyond the gravel pad and enter the environment. Impacts associated with visual resources would be to the surrounding vegetation and result in a contrast in color between the affected vegetation and soil, and the natural landscape.

Commercial Gas Development

Impacts to visual resources associated with surface disturbance and surface facilities for development and production of natural gas infrastructure would be similar to those described for oil development, though there would be no impacts from an oil spill. If natural gas production facilities are associated with existing oil infrastructure there would be some additional visual impacts associated with pipeline offset impacting additional acres if gas is transported on separate aboveground VSMs. If a gas pipeline is buried—considered the more likely scenario—there would be some change in line, color, and texture. These changes would result from the disturbance of irregular, predominately green, rough vegetation to a more regular, brown, smooth area of soil as seen within the Foreground–Middleground Zone. Facilities associated with a compressor station along a gas pipeline would introduce vertical, blocky, colored facilities similar to CPF structures into a predominately horizontal, green, irregular landscape and be visible within the Foreground-Middleground Zone and the Background Zone from some locations. These facilities would impact additional acres. It is anticipated that Alternative D would result in greater impacts to visual resources than Alternatives A and B because there is greater prospect for development, but less than Alternative C both because less lands are made available for leasing and because less miles of gas pipeline are expected to occur.

4.6.17.3 Effectiveness of Stipulations and Required Operating Procedures

Although there are no ROPs or lease stipulations specific to visual resources, ROPs and lease stipulations designed to minimize impacts to solid and hazardous wastes; regulate overland moves, seismic work, and exploratory drilling; and regulate facility design, construction, and siting would reduce the visual impacts that would occur under Alternative D. In addition, approximately 211,000 acres around Teshekpuk Lake would be deferred from leasing and development, further protecting visual values. Restricted Surface Occupancy stipulations on approximately 1,451,000 acres will help reduce impacts to visual resources by restricting certain activities associated with exploration and oil and gas development (see Map 2-4).

4.6.17.4 Conclusion

Under Alternative D, as many as 11,650 miles of seismic and camp lines will impact 107,996 acres. This is the same as under the other alternatives. Other temporary facilities such as ice roads, pads and airstrips, associated with exploratory drilling would impact up to 20,202 additional acres. Most of the combined 128,198 acres could be in various states of recovery from

greening and ring effects. It is anticipated that up to 782 miles of pipelines would be constructed under this alternative, creating surface disturbance of up to 1,463 acres. There could also be approximately 4,376 acres of disturbance associated with gravel pads, roads, gravel sites, pump stations, staging bases, and Central Processing Facilities. Visual impacts associated with this alternative would be approximately 2.9% of the planning area. Approximately 211,000 acres would be deferred to leasing and development around Teshekpuk Lake while another 1,451,000 acres would have Restricted Surface Occupancy stipulations.

4.6.18 Economy

4.6.18.1 Activities Not Associated with Oil and Gas Exploration and Development

Impacts of non-oil and gas activities are likely to be the same as those for the other alternatives. Recreational river rafting will occur in the planning area, primarily on the Colville River. BLM estimates (Table 4.2-A) up to 22 trips each made by 4 persons taking place each year. Employment generated by this activity would result from air taxi service and guide service. Neither of these services originate within the planning area. Air taxi services used for Colville River access originate in Bettles, Kotzebue, Fairbanks, and Coldfoot. Guides originate in Bettles, but may also originate from other locales in Alaska outside the North Slope, or may originate outside Alaska entirely (Delaney 2007). Permitted commercial guided activities will result in fees to the Federal government. Operators or guides pay approximately $600 per year for BLM permits. BLM estimates their clients pay $1,200-$1,500 each for a trip.

Other activities such as research or surveys, various ground activities, and aircraft use not related to petroleum are shown in Table 4.2-A, Summary of Selected Non-Oil and Gas Related Management Activities. North Slope Borough residents may be employed in some of these activities, as will be other Alaskans and nonresidents.

4.6.18.2 Oil and Gas Exploration and Development Activities

In Alternative D, oil and gas exploration and development activities will increase revenue and employment over the life of the fields. The construction, operation, and servicing of facilities associated with oil and gas activities would also result in increased property-tax revenues. The year 2021 initiates substantial production for this alternative (31.9 MM bbl). Peak production in this alternative is calculated at 72.2 million barrels in 2041, 76.4 million barrels in 2051, 74.2 million barrels in 2061, and 73.5 million barrels in 2071. By these dates, up to 7 central processing facilities will be in operation. We indicate revenue for 2021 as it is the first year of substantial production for all alternatives (31.9 MM bbl). In this case, up to 30% more exploration and delineation wells may be drilled than in the Alternative A scenario as all fields are developed.

Revenues

Bonus bids may total as much as $49.2 million in offers for the 373,000 acres newly opened to leasing under this alternative. Exploration, development, and production activities are estimated to generate property tax revenue to the North Slope Borough of about $43 million in 2021, while capital costs will be depreciated as operation continues, lowering property tax over the life of the operation. Other local, state, and Federal revenues are also anticipated to increase under this alternative. The estimated 2045 royalty payments split equally by the State of Alaska and the Federal government exceeds $1.3 billion. State Taxes will be approximately

$98 million, and Federal income tax will be over $1.1 billion. In addition, $666 million in state severance taxes could be generated in 2045. These estimates are based upon average imported crude oil prices in 2005 dollars from the Annual Energy Outlook 2007.

Table 4.6-B. Alternative D Revenues (in millions of 2005 dollars)

Alternative Revenue	Bonus Bids	Royalty		Property Tax		State Tax		Federal Tax		Severence Tax	
Year		2021	2045	2021	2045	2021	2045	2021	2045	2021	2045
D	49.2	325	1,312	43	245	29	98	325	1,112	165	666

Employment

In this alternative we expect 7 exploratory wells each year in five year increments as a lease is explored. Additional fields will also be delineated by exploratory wells over thirty years after initial activity. Direct employment will be higher than Alternatives A or B, as high as 3400 by 2045 when three CPFs are operating, a fourth under construction, with wells and infrastructure being added. Increased indirect employment will result from added capital investment over the life of all fields in this alternative.

Table 4.6-C. Alternative D Estimated Employment in the Field

Tasks/Alternative	Year	Total Direct	Total Indirect	NSB Direct	NSB Indirect
Survey	2008-9	Same as A	Same as A	Same as A	Same as A
Exploratory well drilling	2010-15	210-420	600-1,200	14-28	10-20
CPF, and infrastructure development	2016	500-800	Same as C	Same as C	Same as C
CPF operation development well drilling, sale line construction	2017	500-680	Same as A	Same as A	Same as A
Pad, development wells road, pipe, 3 CPFs in operation, CPF under construction	2045	1,700-3,400	Same as C	Same as C	Same as C

Commercial Gas Development

Natural gas development and production from the NPR-A would generate additional employment. Construction of pipelines would provide substantial numbers of construction jobs for the winter seasons of installation. It is likely that a portion of construction workers would reside in the NSB. Once in operation, gas development would not result in substantial increases in employment over that associated with oil production. However, if gas development occurs as oil production is decreasing or ceasing, the addition or shift to gas production may prolong employment from planning area petroleum production. Development would generate additional property taxes and royalty income for the NSB and State, more severance taxes for

the state, and additional royalties for the Federal government. To the extent that industry is attracted to bid on leases for their gas rather than oil production potential, gas development opportunities could increase interest and bid amounts at lease sales within Northeast NPR-A, providing additional revenues for the Federal and state governments. Alternative D offers less land for oil and gas leasing than Alternative C, but is anticipated to prompt more development than Alternatives A and B, so it is anticipated to have less impact on employment and revenues than Alternative C, but more than Alternatives A and B.

4.5.18.3 Conclusion

Most revenues and employment generated by oil and gas exploration and development under Alternative D would be greater than under the Alternatives A and B and similar to or lower than Alternative C. Approximately $245 million would be generated annually in property taxes, by 2045. The royalty would be total $1.3 billion, to be shared by the Federal government and the State of Alaska. The number of jobs created by exploration, development, and production would be similar to Alternative C. The likelihood for disruptions to the harvest of subsistence resources and associated economic impacts would be greater than under the Alternative A.

4.6.19 Public Health

4.6.19.1 Activities Not Associated With Oil and Gas Exploration and Development

Under Alternative D, the effects of non-oil and gas activities and the potential for increased tourism because of interest generated by leasing in the area could all lead to short term disturbances. It is not anticipated that these activities would be substantially more frequent under Alternative D than under Alternative A. Thus, the health effects from activities not associated with oil and gas exploration and development under Alternative D would be similar to those described under the other alternatives. In general these effects would be temporary and localized. On an individual basis, such events could be highly significant. But because the activities not associated with oil and gas development are expected to be short term, localized, and sporadic, they would not be expected to result in overall population health changes.

4.6.19.2 Oil and Gas Exploration and Development Activities

Effects of Disturbances

Under Alternative D, the public health effects would be similar in nature, but generally greater in magnitude than those anticipated under Alternative A. Revenue to the NSB and state would be substantially higher under Alternative D than Alternative A. Increases in the amount of area available for leasing and exploration would have a corresponding increase in the effects to subsistence harvests as compared to those for Alternative A. The development proposed for the planning area would require increased staging and overland travel during the winter, and in summer would require increased use of aircraft for supplies, equipment, and crew changes, as compared to Alternative A. In turn, this would result in a relative increase in presence of oil industry personnel in the villages and subsistence areas. In all seasons, noise, lights, personnel, and traffic near oil and gas-related infrastructure could temporarily deflect or divert caribou in areas where activities are occurring; however, gravel pads could attract caribou during some seasons as insect-relief habitat. These effects could change the distribution, timing, and location of the caribou harvest, which could require increased effort and expenditure, travel

time and risk on the part of subsistence hunters, resulting in sociocultural consequences such as increased stress and a decreased sense of well-being. Development in and near rivers which serve as important sources of fish harvest could also lead to decreases in the total fish harvest for impacted villages.

1. Diabetes Hypertension, and Associated Metabolic Disorders

As described in **section 4.3.19**, diabetes, hyperlipidemia, and hypertension – collectively termed "metabolic disorders" here, would result if subsistence were displaced from its current contribution to the diet. These disorders are among the primary risk factors for cardiovascular, cerebrovascular, and chronic renal disease. Metabolic disorders are disproportionately common in AI/AN groups compared with the U.S. population. However, because of the high consumption of subsistence foods in communities depending on the planning area, rates of diabetes in the North Slope Inupiat are among the lowest in the U.S., including among non-natives (Naylor et al 2003; Bjerregaard and Jorgensen 2004; Zinman; Murphy et al 1997; Young et al 1992; Bjerregaard, Young et al 2004). Hence subsistence constitutes the primary protection against these disorders, and any substantial decrease in subsistence harvest would place communities at higher risk.

Under Alternative D, impacts to subsistence would be greater than under Alternatives A and B, but less than under Alternative C. With development occurring in roughly 95% of the planning area including in sensitive resource-rich areas around Teshekpuk Lake, impacts would occur through displacement of animals and hunters, but also potentially through population decline, contamination, or concerns about contamination of subsistence resources. Furthermore, the modernization and acculturation pressures described under **section 4.4.13** would tend to foster a shift toward a 'western' diet (Schraer and Bulkow 1993; Curtis, Kvernmo 2005; Nobman, Ponce et al. 2005; Condon et al. 1994). The sociocultural effects and impacts to subsistence are expected to be greater under Alternative D, which would contribute to a greater risk of diabetes and related metabolic disorders. Increased employment would provide income for subsistence equipment, but this benefit would be offset by the difficulty of balancing work schedules with subsistence activities.

2. Food Insecurity and Hunger

As described in Alternative A, food insecurity and hunger are considered to be severe health problems even before malnutrition or starvation occur. Impacts to subsistence resources – and the potential for impacts before they actually occur – would be greater under Alternative D than Alternative A, similar to impacts under Alternative B, and less than Alternative C. Both food insecurity and hunger would be likely to increase under alternative D if significant decreases in harvest success occur. In such a scenario, kinship and sharing networks could be stretched thin. Replacing subsistence foods with store bought foods would be both extremely costly and far less nutritious; the expense of buying high-quality foods in remote Alaskan villages is often prohibitive (Bersamin, Luick et al 2006; Lamden, Receveur et al. 2006). Alternative D would result from the potential loss of resources posed by development in the heart of the most productive subsistence regions in the planning area. To our knowledge, there are no cases of severe protein-calorie malnutrition or starvation in Alaska in recent years. This is likely because of the national and state programs such as food stamps and general assistance, as well as kinship and sharing networks, all of which provide a 'safety net.' Under Alternative B, it is not certain whether these programs would be enough to make up for harvest losses if impacts to subsistence were severe. Starvation is felt to be highly unlikely in view of national, state, and NSB support, but malnutrition could occur in the unlikely event of a severe reduction in the availability of subsistence foods.

3. Social Pathology

Social pathology would be more likely under Alternative D than under Alternative A, but would be less likely overall than under Alternative C and similar to Alternative B. Factors which would influence rates include the following. The influx of large numbers of workers and the chance that new roads could be built (though not anticipated) connecting the planning area with the road system would effectively provide routes for more ready importation of illicit alcohol and drugs; this would also place a heavy burden on already taxed local law enforcement. Data shows that social pathology is related to access to alcohol in Alaska Native villages, and that VPSO support in villages can substantially improve well-being (Wood and Gruenewald 2006; ANTHC 2006; Chiu and Perez 1998; Martin 2005). Perceived and actual threats to subsistence (which could be greater under Alternative D), coupled with the industrialization of highly valued subsistence lands, would be sources of increasing stress and tension, factors which would also tend to increase social pathology. This effect could be particularly severe if subsistence sharing networks were interrupted by the restriction of subsistence. Sociocultural change, or "acculturation," is associated with intense contacts with outside social systems and cultures, such as would occur under this alternative with the influx of oil workers to from outside the region. Rapid sociocultural change is well-established as a cause of social pathology and related health problems in Arctic Indigenous populations (Curtis, Kvernmo et al 2005; Bjerregaard 2001; Wexler 2006) These effects would likely be most intense in Nuiqsut, which lies between the road system and the planning area, but might be experienced by Anaktuvuk Pass, Wainwright, Atqasuk, and Barrow as well as development of the region expands. Interruption of sharing networks, if severe enough, could have effects on other villages as well. Stress produced by the loss of traditionally important hunting range, and the fear of curtailed ability to continue pursuing a subsistence way of life, food insecurity, and the longer travel distances and more difficult hunting conditions produced by displacement of subsistence resources and hunters by oil infrastructure would all contribute to increases in social pathology. Rosemary Ahtuangaruak, a former mayor of Nuiqsut who also worked for years as a community health aide and trained as a physician's assistant, described the link between subsistence and social pathology:

> When our people can feed themselves, they're very happy. They don't care if they don't have a job as long as they're providing for their families, as long as they have the hope in their mind of the possibility to provide for their families. You take away that hope, and you're going to have many, many people that we lose to the ills of social ills. (Rosemary Ahtuangaruak, in MMS 2001).

On the other hand, data from other populations has fairly consistently shown that economic development and increased employment generally have favorable impacts on rates of social pathology. Travis (1987) showed that in Inupiat communities, the increased risk of suicide caused by rapid modernization and acculturation is mitigated to some degree by economically favorable conditions. Haley (2004) found that strong preexisting economic systems helped a North Slope community cope with the rapid economic change brought by development. One study, however, found that in Inupiat communities, increased employment was not always associated with improved well-being, because of the tensions created between work and subsistence (Martin 2005). However, most North Slope residents tend to view employment opportunities as a positive, particularly if flexibility to allow continued active participation in subsistence can be built into the work schedule.

Overall, the trend toward increases in social pathology would be most dependent on impacts to subsistence traditions, sharing networks, and the degree to which the proposed action results in illicit importation of drugs or alcohol. The stress associated with widespread community fears

about the implications of leasing in this area is evident in community testimony, and will likely contribute to social pathology regardless of actual impacts from development in the region. Improved employment and income opportunity would offset these problems to some degree, but overall trends in social pathology would likely mirror the trends toward socio-cultural disruption as described in **section 4.6.13**.

4. Injury

Injury rates tend to parallel social pathology, reflecting alcohol-related injury, suicide, and rates of violence (ANTHC 2006, injury statistics). Under Alternative D, injury rates would tend to parallel the trend toward increased social pathology described above. Additionally, the potential for displacement of hunters and subsistence resources could compound this problem, as longer and more difficult hunts would be associated with a higher risk for injury as well.

The public safety system would face additional stresses coping with large numbers of oil workers entering communities and traveling through the region, making it difficult for communities to adequately enforce prohibition laws. Studies in the region have shown a strong association between adequate police support, effective prohibition laws, and decreased injury rates (Wood and Gruenewald 2006).

5. Health Problems related to EPA Criteria Pollutants

Airborne emissions produced by exploration and development under Alternative D would be greater than Alternative A, less than Alternative C, and similar to Alternative B (**section 4.6.1**). However, we estimate that the overall contribution of emissions to PSD class II requirements would be small. EPA Criteria Pollutants (NOx, SO_2, $PM_{2.5}$, PM_{10}, ozone, lead, and CO) are associated with a range of acute health effects, including exacerbation of chronic lung disease and asthma, increased risk of cardiac arrhythmias, exacerbation of atherosclerotic coronary artery disease, and excess overall mortality, particularly among vulnerable groups such as young children, elders, and people with chronic illnesses. According to the EPA, $PM_{2.5}$ in particular is associated with "increased respiratory symptoms, such as irritation of the airways, coughing, or difficulty breathing, for example; decreased lung function; aggravated asthma; development of chronic bronchitis; irregular heartbeat; nonfatal heart attacks; and premature death in people with heart or lung disease" (EPA 2005).

Current air quality assessments on the North Slope are based on scientific judgment and limited modeling. Both the EPA and the State of Alaska have established legal limits for air pollution based on scientific evidence, known as Ambient Air Quality Standards, to protect public health, including the health of sensitive populations such as asthmatics, children, and the elderly. However, according to EPA analysis and several independent studies, substantial health effects accrue at even levels below NAAQS standards, down to ambient levels (Ostro et al 2006; USEPA 2006b). The health effects include higher overall mortality rates and higher loss of 'quality adjusted life years,' a measure which takes into account time lost from illness. From the standpoint of the North Slope population, one of the most important findings of these data is that the impacts fall disproportionately to vulnerable populations (elderly, very young, and people with chronic illnesses). Given the baseline health disparities described in **section 3.4.10**, North Slope communities would face substantial risk from increased particulate emissions, even if air quality continued to meet NAAQS standards. The state of Alaska, however, has not yet adopted a standard for $PM_{2.5}$, for which the EPA established regulatory criteria more recently. The deadline for the state to adopt new $PM_{2.5}$ standards is December 2007. Consequently, there are no data available for $PM_{2.5}$ levels on the North Slope.

The NSB has expressed strong concern that the models used to predict air quality on the North Slope have not been adequately validated, particularly in view of the arctic climate conditions. The NSB and AI-TC have further asserted that, because of the health disparities and vulnerabilities in North Slope villages (including the high prevalence of certain cancers and pulmonary disease, as described in **section 3.4.10**), it is critically important to establish a scientifically robust monitoring program to validate the current predictions.

Health effects under Alternative D would be less than Alternative C, more than Alternative A, and similar to Alternative B. Given that development would occur closer to actively used subsistence camps and hunting areas, the emissions under this alternative may result in a greater risk of exacerbation of chronic pulmonary disease, and cardiovascular and pulmonary mortality among vulnerable groups. However, occasional exposure to acute low air-quality events is more likely than chronic exposure to poor air quality. Due to the distance of potential development from most population centers, substantial reductions in village air quality is unlikely.

6. Health Problems Related to Other Contaminants

Under Alternative D, development could occur over much of the most important subsistence range in the North Slope region. Emissions would be greater than under Alternative A because of the greater extent of exploration and development-related activities. Oil spills are another route through which contaminants could contact the human population, either directly or through pollution of air, water, and subsistence resources. North Slope residents have expressed concern that development in the Teshekpuk Lake region would pose a particular danger because of its proximity to resources and popular hunting areas.

Public health data support the link between contaminants produced by oil development, and the risk of cancer, endocrine disruption, and cognitive disorders (Jacobsen et al 1996; Arctic Monitoring and Assessment Program 2003; Cone 2005). Data from other communities in which the “total petroleum hydrocarbons” concentrated in water (from air and waterborne sources) has documented a correlation between proximity to oil and gas exploration and production and health outcomes, including cancer and miscarriages (San Sebastian, Armstrong 2001, 2002; Hurtig, San Sebastian 2002). However, NSB and state monitoring to date has indicated that the subsistence food supply in the North Slope region as a whole is quite safe, and have concluded that the “benefits of a traditional food diet far outweigh the relative risks posed by consumption of small amounts of contaminants in traditional foods” (Alaska Native Health Board, 1999).

An accurate determination of specific HAP quantities and potential impacts is not feasible at this stage, given that particular site-specific development activities and pollution controls are not yet able to be predicted. Furthermore, there are few direct data addressing water or air concentrations of many contaminants in the region, nor are there data regarding levels of these contaminants in the human population. HAP are a source of great concern for North Slope residents, who feel that their exposure to contaminants is likely to be significantly greater than the general population because of their extraordinarily high rates of consumption of fish and game which feed in the region.

Thus, although data support the conclusion that the overall benefits of maintaining an active subsistence lifestyle, culture, and diet outweigh the unproven risks posed by North Slope contaminants, data are insufficient to allow accurate modeling of the public health risks under this alternative. The level of predicted development activity and the extent of reliance on

resources in the area, however, suggest that there is justification for concern, investigation, monitoring, and efforts to minimize potential routes of exposure.

7. Infectious Diseases

As outlined in **section 3.4.10**, the prevalence of pulmonary disease is high; rates of HIV and syphilis are substantially lower in the North Slope than in the Alaskan and U.S. general population (Alaska Department of Public Health 2002 and 2005); Chlamydia rates are much higher in Alaska Natives than non-Natives in Alaska – there are no north Slope-specific data available at this time (Alaska Department of Public Health 2006). In our discussions with health care providers in the region, many commented that the North Slope community appears particularly vulnerable to respiratory infections. This observation has been made in other coastal Alaska Native populations as well (Singleton, Bruden et al. 2006).

Under Alternative D, there would be a greater potential for transmission of infectious diseases than under alternative A, owing to a greater projected level of activity in the region, including greater influx of workers from outside the region (refer to **section 4.5.18**). Transmission of respiratory infectious would be of greatest concern to vulnerable members of the community, including people with chronic illnesses and elders. Under Alternative D, an influx of personnel from outside of Alaska – where HIV and syphilis rates are generally substantially higher – could expose villages to a significant risk of increased incidence of these diseases. The NSB health department has tried in the past to address this problem though sending boxes of condoms to oil camps near villages, but existing resources in the NSB have not allowed a more coordinated public health effort to study or monitor transmission rates, nor to develop a more detailed public health approach to prevention. Diarrheal illnesses, common in groups of workers living and working in small enclosed facilities such as oil camps, could also pose a threat if infection spread to the community. Permanent roads linking the planning area with the road system could be allowed under Alternative D. Although considered unlikely, if constructed, permanent roads could lead to increased travel to and from the planning area, and thus serve as another potential source of exposure to infectious diseases

8. Social Determinants of Health

There would be substantial differences in impacts to the social determinants of health between Alternative A and D. Adverse effects would come from greater impacts on subsistence, leading to the potential for decreased social capital and stress; there would be more influx of non-Native employees through the villages (see **section 4.6.18**), leading to the potential for acculturation stresses; there would be a tendency toward more problems of addiction, as described under "social pathology" above; if the increased development activity anticipated under this scenario translates into increased income to local native corporations, there could be increases in relative income disparity within villages; and there would be feelings of frustration, loss, disempowerment, and anger over the industrialization of a region of special and unique importance to Inupiat culture. Referring to Table 4.3-D, these issues would impact social determinants including the social gradient, stress, social capital, and culture, income inequality, and environmental quality, all of which have well-documented public health implications.

There would be substantial benefits as well. Increases in employment and income would tend to benefit community well-being, particularly if local communities are able to work out adequate provisions for subsistence leave; income would also facilitate subsistence. As stated previously, the funding for infrastructure, public safety, and public health, as well as employment in the NSB comes almost entirely from oil and gas development, and this alternative would offer greater revenue to continue these programs.

Thus it is possible to identify both positive and adverse impacts to the social determinants of health from Alternative D. Given the central importance of subsistence to community well-being, if subsistence livelihoods are impacted such that communities are forced to substantially reduce their reliance on subsistence, it is likely that there would be an overall adverse impact on communities.

Effects of Abandonment and Rehabilitation

The North Slope economy and citizens have become heavily dependent on revenue, employment, and income from oil and gas development. Under Alternative D, income would be substantially higher than under Alternative A, and employment is estimated to be times greater than Alternative A (Table 2-3). This could lead to greater dependence on economic resources, and a shift in the balance of the "mixed wage work-subsistence" economy. After the termination of development, revenues to the NSB and local Native corporations would likely decline considerably. The rehabilitation work available may lead to a transient increase in employment, but this would likely be followed by a period of significant economic contraction, both because of decreasing NSB revenues and because of loss of direct jobs. As noted previously, economic depression and job loss are strongly associated with social pathology, which would likely increase during this period. It is possible that subsistence resources could become more readily accessible after a period of adjustment, but this must be viewed as purely speculative. If this occurred, it would help offset effect of decreasing capital available for purchase and repair of hunting equipment and fuel purchase. The decline of these revenues is likely to have profound effects. It is not at all clear whether people will be able to resume their pre-development way of life, whether subsistence resources will have become depleted, contaminated, or displaced, or how people will continue to support a lifestyle which depends heavily on modern technology. Viewed from the perspective of the social determinants of health, this period will have substantial implications for health given the large-scale economic and employment transition anticipated. Another concern would come from the potential leakage of contaminants from wells and dumpsites: residents have expressed concern that if the area is less stringently monitored after development ceases, contamination of rivers, lakes, and estuarine habitats could ensue and would be missed, with substantial implications for human health.

Effects of Oil Spills

Oil spills can affect human health in a number of ways. Direct contamination can produce toxicological effects; rashes and respiratory symptoms have been documented after acute exposure (Lyons, Temple et al. 1999). Longer-term effects from contamination of subsistence resources by organic compounds such as polycyclic aromatic hydrocarbons could lead to chronic exposure-related illnesses such as cancer, birth defects, miscarriages, and endocrine disruption (AMAP 2002; San Sebastian, Armstrong et al. 2001, 2002). Social and psychological effects of large oil spills are also a significant source of morbidity. Residents in the vicinity of an oil spill have been shown to have higher rates of anxiety disorder and post-traumatic stress disorder (Palinkas, Petterson et al 1993; Lyons, Temple et al 1993) A large oil spill could result in a significant decrease in subsistence activity, as was seen after the Exxon Valdez oil spill. In turn, this would to marked changes in social organization, decreased social capital, decreased consumption of subsistence foods, and an attendant increased risk of social pathology, injury, and diabetes and metabolic disorders (re. social capital and EVOS: Ritchie and Gill 2004). The magnitude of these problems would depend largely on the extent of the spill, and the degree to which it impacted local subsistence resources. Under Alternative D, the risk of a large spill is estimated to greater than under Alternative A, raising the chance that some of these health problems could occur.

4.6.19.3 Effectiveness of Stipulations and Required Operating Procedures

The performance-based lease stipulations and ROPs developed for Alternative B would also apply to Alternative D (see **section 4.4.19.3** for an assessment of the effectiveness of the ROPs and lease stipulations). Under Alternative D oil exploration and development could occur over a wider area, in more sensitive areas and habitats, and in lakes.

When considering the effectiveness of stipulations in mitigating public health effects, it must be recognized that because the Inupiat people continue to value this land deeply as a foundation of well-being and culture, any measure which contributes to minimizing the environmental impacts of development in the region can be seen as contributing positively toward overall health and well-being. On the other hand, North Slope residents and the North Slope Borough have expressed a great deal of concern that the new "adaptive management" strategy adopted in Alternatives B, C and D may result in considerable weakening of protections for the area, and well as creating a situation of perpetual flux and uncertainty as the increased flexibility offered under the new system creates the opportunity for important protections to be overridden by economic and industry concerns. Hence, from this perspective, the entire adaptive management program may be seen as a significant stressor, with the attendant health problems as described in **section 4.5.19.2** on social determinants of health above.

Overall, the extent to which the Stipulations and Required Operating Procedures for Alternative D mitigate human health concerns will be proportional first to the degree to which the flexibility they provide is enforced to protect the local environment; to the degree to which they prevent impacts to subsistence resource populations, displacement of subsistence resources, and displacement of hunters and their families; on the efficacy of controls on environmental contamination, and on measures taken to reassure the community regarding their concerns about environmental contamination; and on the degree to which they prevent the adverse consequences of sociocultural change and support the positive aspects associated with employment and economic opportunity. Overall, however, in the face of expanding development, particularly with the development of important subsistence areas, it is likely that there would be substantial unmitigated impacts to health and the social determinants of health.

4.6.19.4 Conclusion

Under Alternative D, the possibility of public health impacts would be substantially increased compared with Alternative A. These impacts would occur primarily through restriction in subsistence; influx of large numbers of outside workers; new access routes to the community; sociocultural and economic change; altered employment; and contaminants. Diabetes, hypertension, and related metabolic disorders would be expected to increase as subsistence is curtailed or as sociocultural changes lead to alterations in dietary patterns. Given that Alternative D involves substantially more development in and near particularly sensitive habitat and hunting and fishing areas, the risk of dietary change and the resultant increases in metabolic disorders would appear to be significantly greater. Cancer, lung disease, endocrine disruption, and neurodevelopmental delay are related to contaminants common to oil and gas development. Although at present no evidence exists to conclusively link rates of any of these problems to local oil development, because of both the increased total emissions projected under this Alternative, and the location of operations within an important subsistence area, the risks of these problems would be increased under Alternative D. Mitigation includes stipulations which regulate discharges, and permits to comply with ADEC and CAA provisions, but exemptions for fine particulate and HAP make these regulations less effective. Social pathology

could result from the economic changes anticipated; from increasing access to drugs and alcohol; and from stress and maladaptive coping given the impacts to wider regions of important traditional use areas. While measures such as Stipulation 63 in Alternative A and ROP I-1 in Alternative D, which mandates a cultural orientation program, and stipulations and ROPs that protect subsistence resources would be partially effective, they would not offset the large-scale socio-economic effects discussed in the preceding sociocultural and public health sections.

4.6.19.5 Potential New Mitigation Measures

The same potential mitigation measures are proposed for this alternative as for Alternative B, as discussed in **section 4.4.19.5**. Under Alternative D, these measures would have similar benefits in terms of the range of public health effects they address. Measures 1 and 3 would establish a framework to ensure that potential public health effects are adequately evaluated during the planning process, and establish a mechanism for ongoing monitoring of public health effects. Owing to the greater extent of development predicted under Alternative D, these measures would provide similar but greater overall benefits than those described under Alternative A. Because development would be allowed over a greater region and within particularly important subsistence regions, however, there may also be greater residual overall health effects. Measure 2, Subsistence Harvest monitoring, would provide relatively greater benefit than that described under Alternative A, because of the greater potential for impacts to subsistence under Alternative D, but again with a potential for greater residual effects. Measure 4, Control of Contaminant-Related Health Risk, would provide protection for contaminant-related health problems as well as helping to reassure communities of the continued safety of subsistence resources. Because, under Alternative D, development would be allowed in critically important subsistence areas, this measure would provide relatively greater benefit than under Alternative A. Certainly though, given the greater extent of development, there could also be greater residual impacts, including both contaminant-related health problems, and problems related to decreased consumption of subsistence resources (including metabolic disorders and food insecurity, and social pathology and injury rates). Measures 6 and 7, through adding health concerns into required orientation programs for industry employees, would have equivalent benefits under Alternative D to those described under Alternative A. Owing to the slightly increased risk of oil spills under Alternative D, measure 8 would offer proportionally greater protection.

Potential Effects on Oil and Gas Development

The expense of the above potential mitigation measures varies widely, from insignificant to potentially millions of dollars. To the extent that the potential mitigation measures would add expense to oil and gas activities, they could discourage leasing, exploration, and development of oil and gas.